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16. ABSTRACT

Three significant new features have been added to the computer program of the Climatological Dispersion Model: 1) a calibration package, 2) the capability of providing individual source contribution lists for arbitrary receptors, and 3) a Larsen averaging time transformation package. This report provides documentation for the use of the new features, descriptions of the corresponding algorithms and guidelines for use.

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by

Kenneth L. Brubaker, Polly Brown, and Richard R. Cirillo

Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

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EPA Lead Project Officer: Joseph A. Tikvart
Office of Air Quality Planning and Standards

EPA Co-Project Officer: John S. Irwin
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Preface

The Climatological Dispersion Model (CDM) has been widely used in the development of air pollution control programs. However, users have been hampered in some instances by the lack of several peripheral routines and printouts. These include (1) a source contribution table, (2) internal calibration, and (3) statistical conversion of averaging times.

The addition of these routines and printouts is straightforward, except for the area source contribution table. Due to the mathematical treatment of area sources in CDM, it is computationally difficult to create such a table. However, based on work performed by John Irwin of the Meteorology and Assessment Division (EPA), a satisfactory method was recently developed. It then became desirable to implement at one time all the peripheral routines and printouts noted above. These additions to CDM are documented in this report as an addendum to the CDM user's guide. This report, however, cannot stand alone; it only supplements the original user's guide.*

The computer program which contains the peripheral routines and printouts is designated CDMQC. This computer code provides pollutant concentration estimates which are essentially the same as those given by the original CDM code. However, major revisions and additions to the original code have been necessary so as to incorporate the new routines and printouts.

CDMQC is one of the atmospheric dispersion models on the User's Network for Applied Modeling of Air Pollution (UNAMAP) system. The UNAMAP system may be purchased on magnetic tape from NTIS for use on the user's computer system, or may be accessed through phone lines and time-share computer terminals. For information on accessing UNAMAP contact: Chief, Data Management Section, Meteorology and Assessment Division, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Although attempts are made to thoroughly check out computer programs with a wide variety of input data, errors are occasionally found. In case there is a need to correct, revise or update this model, revisions will be distributed to those who complete and return the mailing form on page v. A user can be assured that the latest version of the CDMQC Model is on the UNAMAP system.

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*Busse, A. D. and J. R. Zimmerman. "User's Guide for the Climatological Dispersion Model." Publication No. EPA-RA-73-024 (NTIS PB 227346/AS), Environmental Protection Agency, Research Triangle Park, North Carolina 27711, December, 1973.

Comments and suggestions regarding this publication should be directed to: Chief, Environmental Applications Branch, Meteorology and Assessment Division, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Chief, Environmental Applications Branch
Meteorology and Assessment Division (MD-80)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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1. INTRODUCTION

This report describes the additions made to the computer program of the Climatological Dispersion Model (CDM) and provides the necessary information to make use of these new features in the model. The basic algorithms used to calculate pollutant concentrations have not been modified, and results obtained using the previous version of the program may be reproduced using the new version. The applicability of CDM has in no way been altered, although substantial additional information may now be obtained from a single computer run.

Three new features have been added:

- a calibration package which allows the user to calibrate the model and obtain statistical information relating model estimates to observations;
- a capability for producing an individual source contribution list at any desired location;
- an averaging time transformation package based on the Larsen procedure, which allows the user to obtain estimated maximum short-term concentrations in addition to long-term values.

This report takes the form of an addendum to the CDM User's Guide (Busse and Zimmerman, 1973), and supplements that report. It is assumed that a copy of the original User's Guide is available to the user. No attempt has been made to include in this addendum any information in the User's Guide which is not directly relevant to the changes which have been made. The expanded computer program which includes the three new features is referred to as CDMQC throughout this addendum.

Detailed descriptions of the algorithms, input and output options and guidelines for use for each of the new features are given in Sec. 2. The total input required by the program is described in Sec. 3 and the output from the program in Sec. 4. The appendices contain a description of the area source contribution algorithm, a discussion of the statistical output produced by the calibration package, a detailed description of a test example, a new general flow diagram showing the overall logic of the program, and a complete set of computer listings.

2. DESCRIPTION OF NEW FEATURES

This section describes the procedures used in the implementation of the model calibration, individual source contribution list, and averaging time transformation features. Also presented are the various options available to the user, the specific input requirements, the specific output for each feature, and guidelines for usage.

2.1 CALIBRATION PROCEDURE

Model calibration is a technique for improving the predictive capability of a general air quality simulation model within some region of interest, based upon the comparison of model predictions with actual air quality measurements. The term model calibration refers specifically to the determination of the coefficients of a linear equation relating observed to predicted concentration values. The determination is done by standard linear least-squares regression methods. Two slightly different calibration procedures were used in the Air Quality Implementation Planning Program (IPP), TRW (1970) and the Air Quality Display Model (AQDM), TRW (1969). The algorithm incorporated in CDMQC is the same as that used in IPP.

Algorithm. In order to provide a direct comparison of model estimates with observations, the "observed" concentration value at each receptor is taken to be *the measured value at that receptor minus the background value.* Thus for each pollutant

$$\chi_i' = \chi_{im} - \chi_{bg} \tag{1}$$

in which

χ_{im} = measured (input) concentration at the i-th receptor

χ_{bg} = background concentration (also input; assumed the same for all receptors)

χ_i' = "observed" concentration at receptor i, assumed to represent the contribution from those sources given in the emission inventory.

This distinction between observed and measured concentration values has been maintained in this addendum and in the captions labeling the output of CDMQC.

For each pollutant, a linear least-squares regression of observed concentration values against calculated values is carried out using standard methods; see for example, Draper and Smith (1966) or Mood and Graybill (1963). This procedure results in the straight line (the regression line) which best fits, in a least-squares sense, the plot of observed versus calculated concentrations, as illustrated in Fig. 2.1.

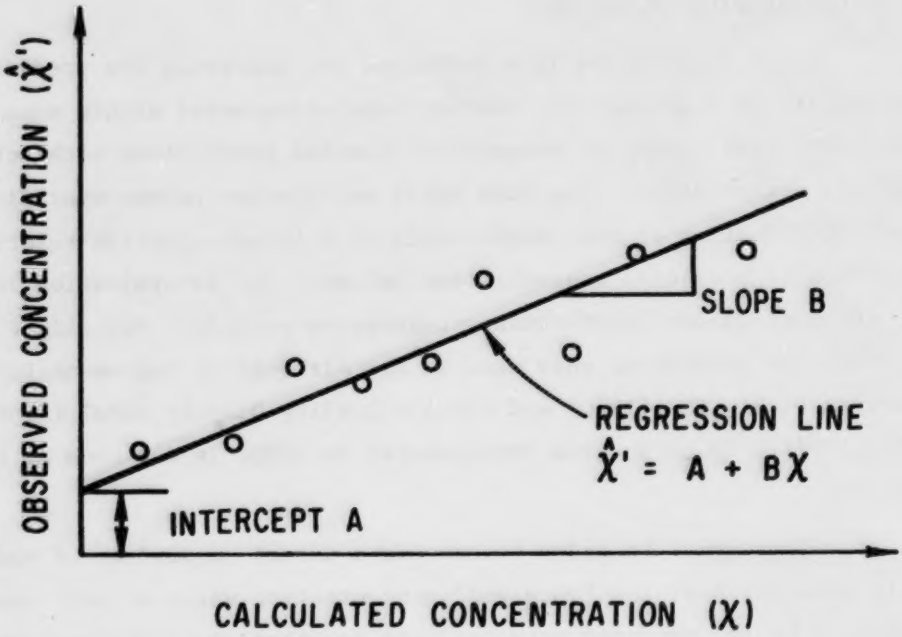
OBSERVED CONCENTRATION $(\hat{\chi}')$
SLOPE B
REGRESSION LINE
$\hat{\chi}' = A + B\chi$
INTERCEPT A
CALCULATED CONCENTRATION (χ)

Fig. 2.1 Model Calibration by Linear Regression

The calibration or regression coefficients are the parameters A and B in the regression line

$$\hat{\chi}' = A + B\chi \qquad (2)$$

and in general are different for different pollutants. In Eqn. (2),

χ = calculated concentration,

$\hat{\chi}'$ = observed (measured minus background) concentration as predicted by the regression line, A = intercept of the regression line on the vertical (observed concentration) axis,

B = slope of the regression line.

If the regression line is statistically significant for the set of receptors at which air quality data is available, then the regression equation is assumed to be valid over the entire region of interest. Thus, the concentration value χ calculated by the basic CDMQC algorithm at any receptor location is adjusted according to Eqn. (3):

$$\hat{\chi} = \chi_{bg} + A + B\chi \qquad (3)$$

in which $\hat{\chi}$ is the calibrated total concentration of the pollutant estimated at the receptor under consideration and all other quantities are as previously defined.

The statistical adequacy of the regression line, Eqn. (2), is tested by comparing the value of the correlation coefficient, a measure of the scatter about the line, against the theoretical maximum correlation coefficient. The theoretical maximum is the maximum correlation coefficient expected to occur by chance when the true value is zero, for the specific number of receptors being used. The maximum value used in the test is the theoretical 5% confidence level value, defined such that there are fewer than five chances out of 100 that a value greater than this would arise solely due to random sampling variation. If the correlation coefficient determined from the regression is greater than this theoretical maximum, it is considered statistically significant at this level of confidence and the regression line is used to adjust the calculated values. If the calculated correlation coefficient is less than the theoretical value, the regression line is not used.

User Options. Four options relating to the model calibration procedure are available to the user. They are specified by the value of the input parameter IOCAL, as indicated in Table 2.1. The first option (IOCAL = 0) was the only option available in the earlier version of CDM.

Table 2.1. Model Calibration Options

IOCAL Value	Option
0	Regression coefficients input by the user and not determined during the current run.
1	Regression coefficients calculated by the program. Program proceeds using the calculated values if confidence level test is satisfied, and stops if it is not.
2	Regression coefficients calculated by the program. Program proceeds using the calculated values if confidence level test is satisfied, and proceeds using values of 1 for slope and 0 for intercept as defaults if it is not.
3	Regression coefficients calculated by the program. The results are printed, and processing stops.

In any given run either one or two pollutants may be treated. If two pollutants are being treated simultaneously, the calibration option selected by the user refers to both pollutants. In the second and third options the statistical test must be satisfied by both correlation coefficients before either set of calculated regression coefficients will be used by the program.

Input. To use the calibration procedure, the user must specify the following information:

- the value of IOCAL appropriate to the desired option,
- the calibration coefficients to be used if IOCAL = 0,
- a background concentration for each pollutant being treated,
- the total number (NCALR) of distinct receptor sites which are to be used in the calibration, and
- a measured arithmetic mean concentration for one or both pollutants at each receptor location.

The total number of sites, NCALR, which are to be used in model calibration must be at least three and no more than fifty. Air quality data from any specific site to be used may consist of measurements for only one or for both pollutants. The actual number of sites used in calibration for a given pollutant is the number for which data is available; this number is determined by the program from an examination of the first NCALR receptors specified by the user in the input data set. For example, if data is available for both pollutants from two sites, for pollutant 1 from a third, and for pollutant 2 from two others, the total number of sites to be used is five and NCALR should be so specified. The actual number of receptors used for pollutants 1 and 2 would be three and four, respectively.

If only one pollutant is to be treated in a given run, that pollutant must be number one. NCALR still represents the number of receptors that the program will examine in its search, except that only those of the first NCALR receptors which have measured concentrations for pollutant 1 will be used. In the simplest case, NCALR represents the number of receptors to be used, all of which are placed at the beginning of the set of receptor cards.

Output. If the user specifies option 0 and inputs the values of the regression coefficients, a message to that effect is printed along with the values of the input coefficients and the background pollutant level(s). If the user attempts to calibrate the model by selecting any one of options 1, 2, or 3, the following results from the regression analysis for each pollutant are printed out:

- regression coefficient values (slope and intercept of the regression line) and the corresponding user-input background value,
- estimated standard deviations of the regression coefficients,
- the calculated correlation coefficient and the theoretical 5% confidence level value,
- an analysis of variance table.

The definition of these quantities and their significance are given in Appendix B. In addition, for each receptor used in the calibration, both calibrated and uncalibrated concentration estimates are printed along with the observed value to allow direct comparison by the user. The calibrated estimates are always obtained using the coefficients determined by the regression analysis.

Guidelines. The importance of providing physically realistic background values should be emphasized. The value obtained for the intercept A depends on the assumed background. Ideally, A should be near zero and B should be near one. Tests can be made to determine if the values actually obtained are significantly different from zero and one at any desired confidence level. The required information is part of the statisitcal output; see Appendix B for a description.

Realistic input background values are particularly important if individual source contribution lists are desired. Any adjustment in the value of the intercept due to unrealistic background values will affect the calibration factor used for determining individual source contributions. See the following discussion regarding the source contribution list feature. Each background value (X_{bg}) should at least satisfy the following conditions:

- X_{bg} must be greater than or equal to zero, and
- X_{bg} should not exceed in value the lowest measured (input) value for the given pollutant.

2.2 SOURCE CONTRIBUTION LIST

For a variety of reasons, it is desirable to know what part of the total predicted pollutant concentration at a given receptor is due to each of the individual sources in the emission inventory. A new feature in CDMQC allows the user to obtain an individual source contribution list for any or all receptors, including those used for model calibration.

Algorithm. At each receptor, the sum of all the individual source contributions plus the background should equal the total calibrated concentration value; however, the basic CDM algorithm determines uncalibrated individual contributions. Eqn. 4 shows the breakdown of the total predicted, uncalibrated concentration (X_i) at the i-th receptor into a sum of N_s source contributions (X_{is}), including both point and area sources:

$$X_i = \sum_{s=1}^{N_s} X_{is} \tag{4}$$

The connection between individual contributions and the final calibrated concentration at the i-th receptor is given by Eqn. 5:

$$\hat{X}_i = X_{bg} + A + B \sum_{s=1}^{N_s} X_{is} \tag{5}$$

Using Eqn. 4, this may be rewritten in the following form:

$$\hat{X}_i = X_{bg} + \sum_{s=1}^{N_s} \left(\frac{A}{X_i} + B \right) X_{is} \qquad (6)$$

Thus the calibrated contribution from source s at the i-th receptor is taken to be

$$\hat{X}_{is} = \left(\frac{A}{X_i} + B \right) X_{is}, \qquad (7)$$

and the total calibrated value $\hat{X}_i$ is thereby represented as a sum of individual calibrated contributions plus the background. The factor within parentheses in Eqn. 7 is simply the ratio of the total calibrated and uncalibrated contributions from known sources, and the assumption is that calibration affects all sources by the same factor. This procedure is identical to that used in the Air Quality Implementation Planning Program (TRW, 1970).

In principle, the sums over s in the above equations run over all sources, both point and area. The manner in which the point source contributions are evaluated by the basic algorithm is simply the straightforward application of the formulas presented in the CDM User's Guide. The contribution from each point source at each receptor position is calculated by the program and is calibrated using Eqn. 7.

The determination of the individual area source contributions is less straightforward due to the procedure used to evaluate the total area source value. A detailed description of that procedure is presented in Appendix A, along with a discussion of the manner in which individual area source contributions are evaluated.

Briefly, the total area source contribution is evaluated by numerical integration, in which the emission rate per unit area is determined at sampling points located on a polar grid centered on the receptor of interest.

The limitations of the numerical approach are due to the finite resolution obtainable using a finite set of sampling points. At great enough distances from the receptor, the angular spacing between sampling points on an arc may correspond to a distance larger than the size of an emission grid square. In such situations, the contribution from a grid square which has been skipped over is not included in the calculations. Even at closer distances, the density of points at which emission rates are sampled is low enough to cause significant error in the evaluation of the average emission rate within a strip unless the variation in emission rate from one grid square to the next is small. The approach used by CDM and CDMQC involves the implicit assumption that area source emissions are relatively uniform and do not vary substantially from one grid square to the next.

The procedure for the determination of individual area source contributions that was adopted in this version of CDM is the following:

1. Evaluate the contribution made by each emission grid square to the total for each arc, and
2. Sum all contributions from each user-specified area source during the process of summing over all arcs in all sectors, to obtain the total contribution from each area source.

The sum of all the individual area source contributions equals the calculated total area source contribution. The procedure for calculating area source contributions is discussed in more detail in Appendix A.

Specifically, the following quantities are saved for each arc which contributes in a given sector:

1. The total contribution from the arc to the receptor in question,
2. The value of q_k for that arc (see Appendix A for the definition of q_k),
3. The value of each of the individual terms in the sum defining q_k (Eqn. 6, Appendix A), and
4. Labels identifying the specific area source(s) associated with each individual term in the sum.

The contribution from each grid square to the total for a given arc is simply proportional to its contribution to the average emission rate, and may be easily evaluated from the quantities just listed. A given grid square may contribute to more than one arc and to more than one sector. The cumulative total for each area source is calibrated using Eqn. 7.

User options. The user has the option of requesting or not requesting a source contribution list for either or both pollutants, at any or all receptors including those used in calibration. For any given receptor, the desired option is specified by the value of the input parameter NCULP as indicated in Table 2.2.

Table 2.2 Source Contribution List Options[a]

NCULP Value	Option
0	No list is printed for the given receptor.
1	A source contribution list is printed for pollutant 1 but not for pollutant 2.
2	A source contribution list is printed for pollutant 2 but not for pollutant 1.
3	Source contribution lists are printed for both pollutants.

[a] If only one pollutant is treated in a given run, that pollutant is always number one, and NCULP should be zero or one.

Input. The only input required of the user in addition to the value of NCULP is the value of the parameter CTOF, which regulates the amount of output from the source contribution algorithm as described below.

Output. Both the calculated calibrated contribution in micrograms/cubic meter and the percent of the total that this value represents are printed for each source explicitly given in the list. As mentioned in the previous paragraph, the user may exercise some control over the amount of output obtained when asking for a source contribution list. Normally, those sources which make the largest contributions at a given receptor are the ones of greatest interest to the user. If an entire source contribution list is obtained, the volume of the output may be inconveniently large, depending on the size of the emission inventory. To bring the amount of output down to more manageable levels, particularly when the principal interest is in the largest contributions, the user may make use of the parameter CTOF. The printing of each individual calibrated point or area source contribution which is less than CTOF percent of the total including background is suppressed. The accumulated total of all these small contributions is printed at the end of the list along with the background and the overall total. By leaving the space corresponding to the input CTOF value blank, or by explicitly specifying a value of zero, the entire source contribution list can be obtained.

Guidelines. No guidelines are required for the use of CDMQC to obtain individual point source contributions since the calculations involved are straightforward. A different situation exists in regard to the area source contribution calculations. The user is cautioned that in order to assure reasonable accuracy, care must be exercised in the specification of the values of the parameters DELR and DINT. Care must also be exercised regarding the interpretation of the individual source contribution list for area sources.

In order to have a basis for the formulation of guidelines, the algorithm for determining individual area source contributions was subjected to a variety of tests. The test procedures and their results are discussed in Appendix A.

Based upon the test results, the following general guidelines for the use and interpretation of the individual area source contribution list seem reasonable:

1. Use the largest emission grid spacing consistent with the desired resolution in the emission pattern;
2. Use the value of DELR which corresponds to the desired maximum range of integration (the maximum distance to which the area source integration will be taken); Table 2.3 gives the maximum range obtainable with various DELR values;
3. Use a value of DINT of at least 10, and preferably higher if area source contributions beyond about seven emission grid squares from the receptor are of interest.

Table 2.3. Maximum Range of Area Source Integration as a Function of DELR

DELR (meters)	MAXIMUM RANGE (kilometers)	DELR (meters)	MAXIMUM RANGE (kilometers)
10	0.990	300	108.3
25	2.475	350	127.4
50	9.800	400	147.6
75	19.500	450	167.4
100	29.500	500	187.5
125	39.500	600	226.2
150	49.050	700	266.0
175	58.975	800	304.0
200	69.000	900	344.7
250	89.000	1000	385.0

The first two guidelines in effect promote the use of the smallest feasible value of the quantity DELR/GRID SPACING. The third is based upon the test results presented in Fig. A.1. The user is urged to consider the specific application of interest, particularly with regard to what level of accuracy is acceptable and over what distance in emission grid square lengths this level of accuracy is desired. Once these factors are considered, the appropriate value of DINT may be approximately determined for the given value of DELR/GRID SPACING by examining Fig. A.1.

In the test example presented in Appendix C, the area source grid has x and y dimensions of 25 km and 20 km, respectively, and all receptors of interest lie within the grid. The diagonal distance across the grid is approximately 32 km, and this represents the maximum range required to include all area sources in the calculation for each receptor without regard to the precise receptor locations. A range of 32 km corresponds to a value of DELR slightly greater than 100 m as indicated in Table 2.3, but the actual positions of the receptors in the test example are such that a value of 100 m may be used and still cover the entire area source emission grid. Consequently, a value of DELR = 100 m was chosen for the example. In accord with the third guideline, a value of DINT = 10 is used in the example. A comparison of the individual area source contributions obtained in the test example using DELR = 100 m and DINT = 10 with those obtained using DELR = 250 m and DINT = 4 (the values recommended in the CDM User's Guide) is presented in Appendix A.

In general, the results from area sources more than a few emission grid lengths from the receptor should not be considered to be as accurate as those from nearby sources. However, the effective grid length is the size of the area source input by the user, not the size of the basic emission square. Since the user may define area sources which are multiples of the basic emission grid square, some additional control is obtained over the accuracy with which the contributions from relatively distant sources may be evaluated. Ideally, to maintain a comparable level of accuracy, the area sources should increase in size as one gets farther away from the receptor of interest.

It is important to re-emphasize that if the area emissions are reasonably uniform, the determination of the total area source contribution may be done with larger radial and angular increments than are required for the determination of individual area source contributions.

Going to smaller radial and/or smaller angular increments will increase the computer time required to a calculation. The radial integral is evaluated using up to 100 strips. Increasing the radial increment (DELR) will not decrease the computer time unless the increment is increased to such an extent that the distance to the edge of the emission grid can be covered in less than 100 steps, in which case the computer time will decrease. The user has direct control over the number of points per arc at which calculations are done, that number being simply DINT + 1. Table 2.4 gives the computer processing unit (CPU) times for a test case involving one sector, for two different values of DELR and three different values of DINT. Each time in Table 2.4 is normalized by the time for 60 arcs and DINT = 4. Sixty arcs corresponds to a range of approximately 50 km with DELR = 250 meters.

Table 2.4. Ratio of (CPU Time for the Indicated No. of Arcs and Value of DINT) to (CPU Time for 60 Arcs, DINT=4)

Number of Arcs	DINT = 4	DINT = 10	DINT = 20
60	1.00	1.13	1.25
100	1.13	1.38	1.63

The results shown in Table 2.4 indicate that a significant increase in computer time may be expected if small radial and/or small angular increments are selected in order to obtain more accurate individual area source contributions.

2.3 AVERAGING TIME TRANSFORMATION PROCEDURE

CDM is designed to calculate arithmetic average concentrations over relatively long averaging times, typically a month, season or year. It is desirable, however, to be able to estimate the maximum concentration for averaging times of a few hours to a day that is likely to occur over a one-year period, in addition to the annual average. Knowledge of the frequency distribution for the pollutant of interest for a variety of averaging times would enable this calculation to be made. Larsen (1971,1974) has shown that in urban areas, the frequency distribution of air pollutants may be approximated to a reasonable level of accuracy by a lognormal distribution for all averaging times. In addition, the median concentrations are approximately proportional to averaging time raised to an exponent, and the maximum concentrations are approximately inversely proportional to averaging time raised to an exponent. Based upon these observations, Larsen developed a procedure by which the maximum concentration, for an arbitrary averaging time, which is expected to occur over a one-year period may be estimated given the annual arithmetic average and the standard geometric deviation for some other known averaging time. The Larsen procedure has been used in both IPP and AQDM, and is the procedure adopted for use in CDMQC

Algorithm. The basic assumption of the Larsen procedure employed in CDMQC is that the actual frequency distribution of pollutant concentration values is approximately lognormal. These Larsen procedures are inappropriate for any pollutant having a concentration frequency distribution that is not lognormal. (Larsen, 1977, has developed a three parameter averaging time model which may be applicable in such situations.) The lognormal distribution is simply the usual "normal" or Gaussian distribution applied to the logarithm of the variable instead of the variable itself. Such a distribution is shown in Fig. 2.2.

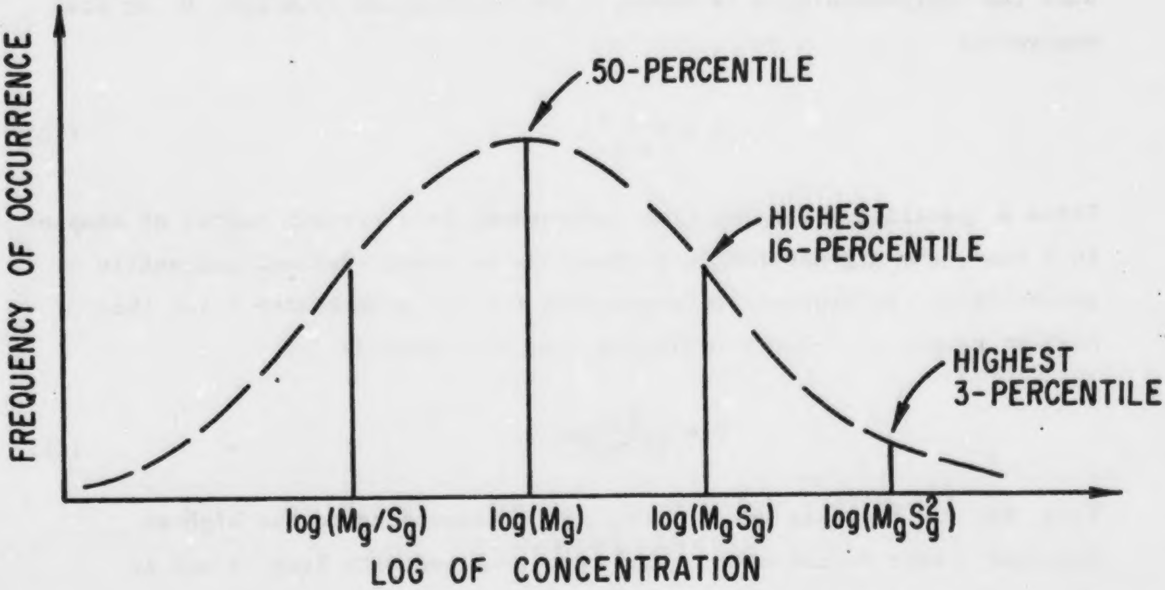

Fig. 2.2 The Lognormal Distribution

Just as the normal distribution is specified completely once the arithmetic mean and standard deviation are known, the lognormal distribution is specified completely once the mean value and standard deviation of the logarithm of the concentration are known. The antilogarithm of this mean is in fact the geometric mean (M_g), and the antilogarithm of the corresponding standard deviation is called the standard geometric deviation (S_g).

Given that the concentration is lognormally distributed, with known geometric mean and standard geometric deviation, the probability P of observing a concentration higher than C is given by Eqn. 8:

$$P = \frac{1}{(2\pi)^{\frac{1}{2}}} \int_{z}^{\infty} \exp\left[-\frac{x^2}{2}\right] dx, \tag{8}$$

with

$$z = \frac{\ln(C) - \ln(M_g)}{\ln(S_g)}, \tag{9}$$

The symbol ln(C) denotes the natural logarithm (i.e., the logarithm to the base e, where $e \simeq 2.718$) of the quantity C. The concentration corresponding to any specified probability, P, or percentile may be determined, since Eqn. 8 implicitly allows the determination of z for a given P. Once the corresponding z is known, C may be obtained from Eqn. 9 or its equivalent

$$C = M_g S_g^{\,z}. \tag{10}$$

Since a specified averaging time corresponds to a certain number of samples in a year, the highest sample corresponds to a well-defined percentile or probability. An approximate expression for the probability P for the highest sample of T-hours averaging time in a year is

$$P = \frac{0.6}{(8760/T)}. \tag{11}$$

Thus, Eqn. 11 provides the probability corresponding to the highest expected T-hour concentration, and when combined with Eqns. 8 and 10 allows the estimation of that value.

Both the geometric mean and the standard geometric deviation for a set of samples are functions of the averaging time, and in order to make the final calculation determining C from z using Eqn. 10, both M_g and S_g must be known for the appropriate averaging time. The standard geometric deviation for an arbitrary averaging time may be obtained from the value for a known averaging time. Assuming for example that the standard geometric deviation for 24-hour samples is known, the standard geometric deviation for T-hour samples may be obtained from Eqn. 12:

$$S_g(\text{T hours}) = (S_g(\text{24 hours}))^k \qquad (12)$$

with

$$k = \left[\frac{\ln(8760/T)}{\ln(8760/24)}\right]^{\frac{1}{2}} \qquad (13)$$

Once S_g is known for the desired averaging time, M_g may be determined using Eqn. 14:

$$M_g = \chi S_g^{-\frac{1}{2}\ln(S_g)} \qquad (14)$$

in which χ represents the arithmetic mean for the same set of samples, precisely the quantity which is calculated by CDMQC.

Thus, given the calibrated annual average concentration as calculated by CDMQC, and the 24-hour standard geometric deviation (assumed known), the maximum concentration value expected to occur in one year may be estimated for any specified averaging time using Eqns. 8-14. Larsen (1974) has further discussed the effect of procedures such as this on design concentrations for determining allowable emissions.

User Options. The user may obtain at any or all receptors, for either or both pollutants, the estimated maximum concentrations for up to three averaging times per pollutant. The averaging times to be used for each pollutant must be specified by the user and are used at each receptor at which the Larsen procedure is applied. For each receptor, the user may request the Larsen statistical output for neither, one, or both pollutants by appropriate specification of the parameter NLARS, on the receptor card, as indicated in Table 2.5.

Table 2.5. Larsen Transformation Options[a]

NLARS Value	Option
0	No averaging time transformation done for either pollutant.
1	Averaging time transformation output for pollutant 1 only.
2	Averaging time transformation output for pollutant 2 only.
3	Averaging time transformation output for both pollutants.

[a] If only one pollutant is treated in a given run, that pollutant is always number one, and NLARS should be zero or one.

Input. If the use of the Larsen procedure is desired at any receptor, the user must supply at least one and up to three averaging times for the pollutant(s) for which the procedure is to be used. The averaging times should be in hours, and are supplied as the input variables PAV(I,J), I = 1 to 3 and J = 1, 2. If only one averaging time is to be used for pollutant J, PAV(1,J) should be specified as this value, with PAV(2,J) and PAV(3,J) left blank. Similarly, if two are to be used, they should be given in the first two positions and PAV(3,J) left blank. The sets of averaging times may be different for the two pollutants, but the same sets are used at every receptor.

In addition to the averaging times, the user must select and specify the appropriate value of NLARS at each receptor, and must also provide observed standard geometric deviation values of the 24-hour samples at each receptor and for each pollutant for which the transformation is to be used. The user must also provide appropriate climatological input data so that annual average concentration estimates are calculated, rather than seasonal or monthly averages.

Output. The following information is printed out for each pollutant and each receptor for which averaging time transformation output is requested:

1. The expected geometric mean concentration for each specified averaging time,

2. The expected maximum concentration for each specified averaging time,
3. The standard geometric deviation for each specified averaging time, and
4. The annual arithmetic mean concentration.

Guidelines. The Larsen procedure employed in CDMQC is an approximate method based on certain assumptions, particularly that of lognormal concentration distributions. If it is definitely known that the pollutant distribution in a particular application is not lognormal, a three parameter model may be used through separate calculations, as discussed by Larsen (1977).

3. DESCRIPTION OF INPUT

This section provides a description of the input required by CDMQC, including a detailed card input sequence listing. The input may be logically divided into four blocks:

- miscellaneous operation data
- meteorological joint frequency function
- source emission inventory
- receptor data.

Of these four parts, only the meteorological joint frequency function input is identical to that for CDM. The changes in the other inputs are not large, however, and relatively little modification of existing data sets will be required to make them usable with the new version.

The discussion will be in terms of cards as the sole input to the program, but in fact only the first two records or card images must be input on logical unit number 5 (by convention, a card reader). All subsequent data must be input on the unit specified by the parameter IRD on the second card. This unit may be the card reader (IRD=5) or any other device set up to supply the required data in the appropriate format.

3.1 GENERAL DESCRIPTION

The first block of data contains miscellaneous operational data including a title card, input and output option specifications, miscellaneous meteorological data, area source emission grid specifications and integration parameters and pollutant background values. This block corresponds generally to cards 1-3 in the basic CDM, although two entirely new cards have been added and a minor change has been made in a third.

The second block consists of the meteorological joint frequency function. No changes have been made from the basic CDM.

The third block consists of the source emission inventory data. For convenience, the point and area inventories are now read in separately, the point source data first, followed by the area source data. The format of the individual cards is such that existing inventory data can be used unchanged except for the separation of point and area sources and the insertion of a blank card between the two parts.

The fourth block consists of the set of receptor cards, and substantial additions have been made to each receptor card compared to the basic CDM requirements. Due to program changes, a limit of 200 now exists on the total number of receptors which CDMQC can treat in a given run. As explained in Sec. 2.1, if calibration is to be done in a given run of the program, the cards for the NCALR receptors involved must be placed at the beginning of the set of receptor cards. Additional receptor cards may follow. Each receptor card contains receptor coordinates, measured pollutant concentrations, pollutant standard geometric deviations, four output control parameters, and an optional four-character receptor identification name. The measured concentrations of either or both pollutants are required if that receptor is to be used for model calibration, but are optional if the receptor is not used for calibration. The standard geometric deviations of either or both pollutants are required if Larsen statistical output is desired for the specified pollutants at that receptor, but are optional otherwise. The coordinates are the only parameters which should never be blank; any or all of the other quantities may be omitted under various circumstances.

Either one or two pollutants may be treated in a single run of the computer program. If only one pollutant is treated, that pollutant must be pollutant 1. A test is made on the name of pollutant 2, LPNAM(2) on card number 3; if this space is left blank, it is assumed that only one pollutant will be treated. If LPNAM(2) is not blank, it is assumed that two pollutants are to be treated. No test is made on the name of pollutant 1. In general, a name should be supplied for each pollutant treated since it is used for identification in the output.

Table 3.1 gives a summary of the differences in input requirements and format between CDM and CDMQC.

3.2 DETAILED CARD INPUT SEQUENCE

Table 3.2 provides the detailed card input sequence for the CDMQC. The parameters are defined in the table for the benefit of the user, but the User's Guide or other sections of this addendum should be consulted if questions arise regarding the significance of any input variable.

Table 3.1. Differences in Card Input Sequence Between CDM and CDMQC

Card number		Modification or Comparison
CDMQC	CDM	
1	--	Entirely new card
2	1	NLIST replaced by new parameters NLIST1 and NLIST2
3	--	Entirely new card
4	2	No difference
5	3	No difference
6-101	4-99	No difference
102-299	100-999	Point source inventory separated
300	--	Addition of blank card
301-999	100-999	Area source inventory separated
1000	1000	No difference
1001	1001	Measured concentrations renamed, new format used; Addition of standard geometric deviations; Redefinition of NROSE output control parameter; Addition of output control parameters IPNCH, NCULP and NLARS; Addition of receptor identifier NRAM.

Table 3.2. Card Input to CDMQC[a,b]

CARD NO.	COLUMN	FORMAT	CONTENTS
1	1-80	20A4	*ITIT (1) - ITIT (20) (Title of run to be printed at top of every page of output)
2	1-8	2A4	AROS (1) - AROS (2) (Identification for punched output of the computed area source concentrations of the two pollutants)
	9-16	2A4	PROS (1) - PROS (2) (Identification for punched output of the computed point source concentrations of the two pollutants)
	17-21	I5	IRUN (Computer run identification number)
	23-24	I2	*NLIST1 (Index governing printout of wind rose input data: If NLIST1$\leq$0, data is printed.)
	25-26	I2	*NLIST2 (Index governing printout of source input data: If NLIST2$\leq$0, data is printed.)
	27-31	I5	IRD (Data input file number)
	32-36	I5	IWR (Output print file number)
	37-41	I5	IPU (Output punch file number)
	42-59	2F9.0	CA(1)-CA(2) (Constants of the linear equation Y=CA + CB x X, used to calibrate the calculated concentrations of the two pollutants considered in the model)
	60-77	2F9.0	CB(1)-CB(2) (Slope of the linear equation, Y=CA + CB x X, used to calibrate the calculated concentrations of the two pollutants considered in the model)
3	1-6	I6	*NCALR (Total number of receptors which will be used in computing calibration coefficients; for either or both pollutants. Leave blank if coefficients not to be computed. NCALR $\leq$ 50.)

Card Input to CDMQC (continued)

CARD NO.	COLUMN	FORMAT	CONTENTS
3 (cont'd)	8-11	I4	*IOCAL (Indicates calibration option desired. If IOCAL=0, regression constants are input and not computed. If IOCAL=1, constants will be computed and processing will stop if confidence level not satisfactory. Otherwise, constants will be used to calibrate. If IOCAL=2, constants will be computed and default values (slope=1, intercept=0) will be used to calibrate if confidence level not satisfactory. Otherwise, calculated constants will be used to calibrate. If IOCAL=3, constants will be computed, the results printed and processing will stop.)
	13-22	F10.0	*BKGR(1) (Arithmetic mean background concentration of pollutant 1, in micrograms/cubic meter)
	23-32	F10.0	*BKGR(2) (Arithmetic mean background concentration of pollutant 2, in micrograms/cubic meter)
	34-37	A4	*LPNAM(1) (Name of pollutant 1)
	39-42	A4	*LPNAM(2) (Name of pollutant 2)
	44-55	3F4.0	*PAV(1,1) - PAV(3,1) (Up to three desired averaging times (hours) for statistical output for pollutant 1)
	57-68	3F4.0	*PAV(1,2) - PAV(3,2) (Up to three desired averaging times (hours) for statistical output for pollutant 2)
	70-74	F5.0	*CTOF (Percentage: sources contributing less than this percent to total calibrated concentration will not be individually listed in any culpability lists.)
4	1-6	F6.0	DELR (Initial integration increment of radial distance from receptor, meters)

Card Input to CDMQC (continued)

CARD NO.	COLUMN	FORMAT	CONTENTS
4 (cont'd)	7-12	F6.0	RAT (Ratio of length of a basic emission grid square and the length of a map grid square)
	13-18	F6.0	CV (Conversion factor which upon multiplication by RAT expresses the distance of the side of an emission grid square in meters. For example, if the map units are in kilometers, CV=1000.)
	19-24	F6.0	HT (Average afternoon mixing height in meters)
	25-30	F6.0	HMIN (Average nocturnal mixing height in meters)
	31-36	F6.0	XG (X map coordinate of the southwest corner of the emission grid array)
	37-42	F6.0	YG (Y map coordinate of the southwest corner of the emission grid array)
	43-48	F6.0	XGG (X map coordinate of the southwest corner of the plotting grid)
	49-54	F6.0	YGG (Y map coordinate of the southwest corner of the plotting grid)
	55-60	F6.0	RATG (Ratio of the length of the grid square used for plotting and the length of a map grid square)
	61-66	F6.0	TOA (Mean atmospheric temperature in degrees centigrade)
	67-72	F6.0	TXX (Width of basic emission square in meters)
5	1-6	F6.0	DINT (Number of intervals used to integrate over a 22.5° sector. Maximum value is 20, typical value is 4.)
	7-12	F6.0	YD (Ratio of average daytime emission rate to the 24-hour emission rate average.)

Card Input to CDMQC (continued)

CARD NO.	COLUMN	FORMAT	CONTENTS
5 (cont'd)	13-18	F6.0	YN (Ratio of the average nighttime emission rate to the 24-hour emission rate average)
	19-54	6F6.0	SZA (1) - SZA (6) (Initial σ_z in meters for each stability class. Six different values can be used, but normally only one value is used.)
	55-66	2F6.0	GB(1) - GB(2) (Decay half life in hours for the two pollutants)
6-101	1-49	[7X, 6F7.0]	F(i,j,k) (Joint frequency function, identical to $\phi(k,l,m)$; i=index for stability class, j=index for wind speed, k=index for wind direction)
[Point Source cards follow]			
102[c]	1-6	F6.0	X (X map coordinate of a point source)
	7-13	F7.0	Y (Y map coordinate of a point source)
	*[a]	*	*
	21-36	2F8.0	S1-S2 (Source emission rate in grams per second for the two pollutants)
	37-43	F7.0	SH (Stack height in meters)
	44-48	F5.0	D (Diameter of stack in meters)
	49-55	F7.0	VS (Exit speed of pollutants from stack in meters per second)
	56-62	F7.0	T (Gas temperature of stack gases in degrees centigrade)
	63-67	F5.0	SA (If this field is blank, Briggs' formula is used to compute stack height. Otherwise, the product of plume rise and wind speed is entered in square meters per second)

Card Input to CDMQC (continued)

CARD NO.	COLUMN	FORMAT	CONTENTS
300	--	--	*This is a blank card which follows information on the emission point sources. It is used to test the end of the point sources and must not be left out.
Area source cards follow]			
301[d]	1-6	F6.0	X (X map coordinate of the southwest corner of an area emission grid square)
	7-13	F7.0	Y (Y map coordinate of the southwest corner of an area emission grid square)
	14-20	F7.0	TX (Width of an area grid square in meters)
	21-36	2F8.0	S1-S2 (Source emission rate in grams per second for the two pollutants)
	37-43	F7.0	SH (Stack height in meters)
1000	--	--	This is a blank card which follows information on the area emission sources. It is used to test the end of sources and must not be left out.
[Receptor cards follow]			
1001[e]	1-8	F8.0	RX (X map coordinate of the receptor)
	9-16	F8.0	RY (Y map coordinate of the receptor)
	30-35	F6.0	*COBS(1)[f](Measured concentration of the first pollutant at the receptor in micrograms/cubic meter. Leave blank if not known.)
	36-41	F6.0	*COBS(2)[g](Measured concentration of the second pollutant at the receptor in micrograms/cubic meter. Leave blank if not known.)

Card Input to CDMQC (continued)

CARD NO.	COLUMN	FORMAT	CONTENTS
1001 (cont'd)	43-47	F5.0	*SGD(1)[h] (Standard Geometric Deviation (24-hour) of pollutant 1 to be used for output at other averaging times)
	48-52	F5.0	*SGD(2)[i] (Same as SGD(1), but for pollutant 2)
	54-55	I2	*IPNCH (A control parameter which, if greater than zero will cause standard concentration output to be punched.)
	56-57	I2	*NROSE (A control parameter for concentration rose output: If NROSE = 0 (blank), no concentration rose data will be printed or punched; If NROSE = 1, concentration roses will be printed but not punched; If NROSE = 2, concentration roses will be printed and punched.)
	58-59	I2	*NCULP (A control parameter which specifies source contribution list option (print only): If NCULP = 0, no list is printed; If NCULP = 1, list for pollutant 1; If NCULP = 2, list for pollutant 2; If NCULP = 3, list for both pollutants.)
	60-61	I2	*NLARS (A control parameter which specifies Larsen statistical output option (print only): If NLARS = 0 (blank), no statistical output; If NLARS = 1, for pollutant 1 only; If NLARS = 2, for pollutant 2 only; If NLARS = 3, for both pollutants.)
	77-80	A4	*NRAM (Optional receptor identification name)

Card Input to CDMQC (continued)

[a] Asterisks denote additions to or changes in card input sequence given in Table 6 of the CDM User's Guide.

[b] The data listed on "cards" 1 and 2 must in fact be input on cards. All data on subsequent "cards" must be input from logical unit number IRD, provided on card number 2. This unit may be the card reader or any other input device which can supply the data in card image format.

[c] There will be as many cards of this type as there are point sources. The maximum number of point sources which can be handled is 200. The next card type will arbitrarily be numbered 300.

[d] There will be as many cards of this type as there are area sources. The maximum number of area sources which can be handled is 2500. The next card type will arbitrarily be numbered 1000.

[e] There will be as many cards of this type as there are receptors. The maximum number of receptors which may be handled is 200.

[f] Required only if this receptor is to be used in calibration for pollutant 1.

[g] Required only if this receptor is to be used in calibration for pollutant 2.

[h] Required only if Larsen statistical output is desired for pollutant 1 at this receptor.

[i] Required only if Larsen statistical output is desired for pollutant 2 at this receptor.

4. DESCRIPTION OF OUTPUT

This section provides a description of the output which may be obtained in a given run of the CDMQC computer program. The user must specify the logical unit numbers for the output; this is done by means of the parameters IWR and IPU on input data card number two. It is intended that IWR refer to a line printer and that IPU refer to a punched card output unit, but they may refer to any other devices compatible with the output format. The discussion will be in terms of printed and punched output. Samples of both types of output for a test example may be found in Appendix C.

4.1 PRINTED OUTPUT

The user has considerable flexibility in specifying what quantities will or will not be printed out. For job identification purposes, a three-line heading is supplied at the top of each page of printed output. This heading consists of the phrase CLIMATOLOGICAL DISPERSION MODEL, below which the user-supplied job title (ITIT(1) - ITIT(20)) is printed, below which the user-supplied run identification number (IRUN) is printed. The heading allows the output to be separated without losing track of what job the output resulted from.

The following information is always printed on the first two pages of output:

- pollutant list (user-supplied pollutant names)
- area source grid specification and integration parameters
- miscellaneous meteorological data including morning and afternoon mixing heights, mean ambient temperature and pollutant halflives
- day and night emission rate factors
- background pollutant concentrations
- the cut-off for source contribution lists
- the calibration option in effect and related input parameters
- averaging times to be used for each pollutant in applying the Larsen procedure.

Following this section of output, the user may have the meteorological joint frequency function printed or not as desired. The joint frequency data will be printed if the parameter NLIST1 is less than or equal to zero (or left blank). The printing is suppressed if NLIST1 is greater than zero.

Similarly, the source emission inventory will be printed next if the parameter NLIST2 is less than or equal to zero (or blank) and will not be printed if NLIST2 is greater than zero.

Calibration results are then printed if calibration is attempted on the given run (i.e., if IOCAL is greater than zero). See Sec. 2.1 and Appendix B for a description of the output from the calibration procedure. An explicit statement of the results of the statistical test on the calculated correlation coefficient(s) is printed along with a statement of the action taken by the program as described in Table 2.1.

The last major section of output contains the calculated concentrations. For each receptor, including those used for calibration, the calibrated calculated point and area contributions for each pollutant treated, the background values, and the total predicted concentration of each pollutant at the given receptor along with the receptor identifier (NRAM) and receptor coordinates are always printed. These results are printed in tabular form.

In addition, the user may request the following additional output at any or all receptors:

- Point and area concentration roses for each pollutant being treated; concentration roses are printed if the parameter NROSE is greater than zero, and not printed if NROSE is less than or equal to zero (or blank).
- Individual source contribution lists for either or both pollutants, according to the value of the parameter NCULP; see Sec. 2.2.
- Results from the application of the Larsen statistical transformation for either or both pollutants, according to the value of the parameter NLARS; see Sec. 2.3.

The order in which the results are printed depends upon the nature of any additional output beyond the basic point, area and total concentration(s) at each receptor. Receptors are processed by the program one at a time in the order in which they are specified by the user. If pollution roses and/or an individual source contribution list are requested for a given receptor, these results are printed out immediately following the calculations and are not saved through the entire run. Consequently, these results are the first to appear, and are arranged by receptor in the order in which the receptors are processed.

Following any pollution roses or source contribution lists requested by the user, the table of point, area and total concentration estimates previously described is printed.

Finally, if Larsen statistical transformation results are requested for either or both pollutants at any or all receptors, these results are printed out in tabular form following the table of annual average concentration estimates. A separate table is printed for each combination of pollutant and averaging time, containing results for only those receptors at which statistical output was requested for the given pollutant.

Examples of each type of output are given in Appendix C as part of the output from the test example.

4.2 DIAGNOSTIC MESSAGES

Three new tests have been added to the program to detect common user input errors and to call the user's attention to their existence when they occur. A brief description of each together with the diagnostic message that is printed follows.

Inconsistent Specification of Area Source Locations. The area source emission grid may be not larger than 50 grid squares in either the x or the y direction, this limit being determined by the dimensions of various arrays defined within the computer program. This limit, together with the user-specified size of a basic grid square (TXX), imposes a limit to the total size of the emission grid. A test is made to see that each area source falls within the boundaries of the grid. If any area source lies partially or wholly outside these boundaries, the following message is printed:

```
NOTE:  AREA SOURCE NNNNN, WITH X COORD XXXXXXX.XX AND Y COORD
       YYYYYYY.YY, VIOLATES AREA SOURCE ARRAY LIMITS.  AREA SOURCES
       MUST LIE ENTIRELY WITHIN A MMMMMMMM.MM METER SQUARE WITH
       SOUTHWEST CORNER AT THE USER-DEFINED ORIGIN (XG, YG).
       AREA SOURCE NNNNN WILL NOT BE INCLUDED IN THIS CALCULATION.
```

In this message, the actual values of all quantities indicated will be printed. The quantities printed are:

NNNNN	Area source ID
XXXXXXX.XX	X coordinate of southwest corner of area source which violates limits.
YYYYYYY.YY	Y coordinate of southwest corner of area source which violates limits
MMMMMMMM.MM	Total possible size of emission grid, equal to (50)(TXX) meters

As indicated in the message, the calculation will proceed but the area source in violation will be omitted from the inventory.

Inconsistent Specification of RAT, CV, and TXX. The user-supplied quantities CV, RAT, and TXX are not all independent, but are related by the equation

$$RAT = TXX/CV. \qquad (1)$$

A test is made to insure that this relationship is satisfied, and if it is not the following message is printed:

```
INPUT ERROR:  RAT*CV MUST EQUAL TXX.  CALCULATION TERMINATED.
```

As the message indicates, the run is stopped after the message is printed. The user must correct the input and resubmit the job.

Insufficient Range in Area Source Calculations. As discussed in Section 2.2 and in Appendix A, the area source algorithm evaluates the average emission rate on a series of arcs centered on the receptor of interest. No more than 100 arcs are used, this limit again being determined by internally fixed array dimensions. This limit, together with the user-supplied radial integration step DELR, imposes an upper limit to the distance to which the area source calculations will be taken. If there are area sources beyond this range, they will not be included in the calculations. A test is made for each receptor to determine if this situation exists, and if it does the following message will be printed:

```
WARNING:  MORE THAN 100 ARCS ARE REQUIRED FOR CALCULATION
          OF AREA CONTRIBUTION.  AREA SOURCES BEYOND 100TH
          ARC ARE NOT INCLUDED IN CALCULATION.
```

The limit need be violated for only one sector at a given receptor in order for the message to be printed. As indicated, the program does not terminate the job, but ignores the contribution from area sources beyond the range. Table A.2 gives the range of the area source integration as a function of DELR.

4.3 PUNCHED OUTPUT

Two types of punched card output for each receptor are available to the user. The first type, called the standard concentration output, consists of one card containing the receptor coordinates in both plotting grid units and in map units, calibrated point and area concentrations, background concentrations, total predicted concentrations, measured concentrations of each pollutant, and the computer run identification number. All concentrations are reported in micrograms/ cubic meter. To obtain the first type of punched card output for a given receptor, the value of the parameter IPNCH on the corresponding receptor card must be greater than zero.

The second type of punched output consists of the point and area concentration roses for each designated receptor. Two or four cards are punched, depending on the number of pollutants treated. Each concentration rose card contains a user-supplied card identifier (PROS(I) or AROS(I), I=1 or 2), sixteen calibrated concentration values corresponding to the sixteen wind directions used, and receptor map coordinates. To obtain this output for a given receptor, the parameter NROSE on the receptor card must be assigned the value 2.

These two types of output are independent of each other; either or both may be obtained at a given receptor. The punching of the standard concentration output is controlled entirely by the parameter IPNCH and the punching of the pollution roses is controlled entirely by the parameter NROSE.

Table 4.1 gives the detailed format of the punched card output available from CDMQC.

Table 4.1. Format of Punched Output

CARD	COLUMN	FORMAT	CONTENTS
1 [a]	1-8	F8.2	PUX (X coordinate of receptor in plotting grid units)
	9-14	F6.2	PUY (Y coordinate of receptor in plotting grid units)
	15-18	I4	KPX(1) (Calibrated area concentration for first pollutant)
	19-22	I4	(2) (Calibrated area concentration for second pollutant)
	23-26	I4	(3) (Calibrated point concentration first pollutant)
	27-30	I4	(4) (Calibrated point concentration for second pollutant)
	31-34	I4	(5) (Input background concentration for first pollutant)
	35-38	I4	(6) (Input background concentration for second pollutant)
	39-42	I4	(7) (Calibrated total concentration for first pollutant)
	43-46	I4	(8) (Calibrated total concentration for second pollutant)
	47-50	I4	COBS(1) (Measured concentration of first pollutant)
	51-54	I4	COBS(2) (Measured concentration of second pollutant)
	55-64	F10.2	RX (X map coordinate of receptor)
	65-74	F10.2	RY (Y map coordinate of receptor)
	75-79	I5	IRUN (Computer run identification number)
	80		I (Card identifier, a literal 'I')
2 [b]	1-4	A4	PROS(1) (Card identifier)
	5-68	16I4	KPX(1)-KPX(16) (Point concentration by wind direction)

Format of Punched Output (continued)

CARD	COLUMN	FORMAT	CONTENTS
2[b] (cont'd)	69-74	I6	RX (X map coordinate of receptor multiplied by 100 to remove decimals)
	75-80	I6	RY (Y map coordinate of receptor multiplied by 100 to remove decimals)
3[b]	--	--	(Same as Card 2 for second pollutant)
4[b]	1-4	A4	AROS(1) (Card identifier)
	5-68	16I4	KPX(1)-KPX(16) (Area concentration by wind direction)
	69-74	I6	RX (X map coordinate of receptor multiplied by 100 to remove decimals)
	75-80	I6	RY (Y map coordinate of receptor multiplied by 100 to remove decimals)
5b	--	--	(Same as Card 4 for second pollutant)

---

[a] Card punched only if IPNCH greater than zero.

[b] Card punched only if NROSE equals two.

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APPENDIX A. DESCRIPTION OF THE AREA SOURCE CONTRIBUTION ALGORITHM

The purpose of this appendix is to describe the algorithm used to estimate both total and individual area source contributions and to present the results of tests carried out to determine the accuracy of the individual area source contribution estimates.

The total area source contribution is given by Eqn. 1 on page 3 of the CDM User's Guide, which is reproduced here with very slightly altered notation:

$$\chi_A = \frac{16}{2\pi} \int \left[\sum_{k=1}^{16} q_k(r) \sum_{\ell=1}^{6} \sum_{m=1}^{6} \phi(k,\ell,m)\ S(r,z;U_\ell,P_m) \right] dr \tag{1}$$

with

$$q_k\ (r) = \int Q(r,\theta)\ d\theta \quad \text{(over sector k).} \tag{2}$$

If we define $f_k(r)$ by

$$f_k(r) = \sum_{\ell=1}^{6} \sum_{m=1}^{6} \phi(k,\ell,m)\ S(r,z=0;U_\ell,P_m) \tag{3}$$

then the total area source contribution may be written as follows:

$$\chi_A = \frac{16}{2\pi} \sum_{k=1}^{16} \left[\int f_k(r)\ q_k(r) dr \right] \tag{4}$$

Both radial and angular integrations are done numerically using the trapezoidal rule. Operationally, the radial integral in Eqn. 4 and the angular integral defining $q_k(r)$ are replaced by

$$\int f_k(r) q_k(r) dr \simeq \Delta r \left[\frac{f_k(r_1) q_k(r_1)}{2} + f_k(r_2) q_k(r_2) + \dots + f_k(r_{M-1}) q_k(r_{M-1}) + \frac{f_k(r_M) q_k(r_M)}{2} \right] \tag{5}$$

and

$$q_k(r) \simeq \Delta\theta \left[\frac{Q(r,\theta_1)}{2} + Q(r,\theta_2) + \ldots + Q(r,\theta_{N-1}) + \frac{Q(r,\theta_N)}{2} \right] \quad (6)$$

The quantity $Q(r,\theta)$ represents the pollutant emission rate per unit area at the location specified by (r,θ). The quantity $q_k(r)$ is proportional to the average emission rate along an arc at a distance r from the receptor. The radial distances r_i, i=1 to M, in Equation 5 are determined from

$$r_i = (i-1)\ \Delta r \quad (7)$$

with

Δr = DELR until $r \geq 2500$ meters,

then

Δr = 2DELR until $r \geq 5000$ meters,

then

Δr = 4DELR thereafter.

The special case of i=1 corresponds to a single point rather than an arc, the point being located at the receptor position. The value of q_k for this "arc" is obtained from the emission rate per unit area of the grid square in which the receptor is located. If the receptor is located outside the emission grid, the first distance at which calculations are done corresponds to the first arc which intersects the grid.

The parameter DELR is specified by the user,and a value of 250 meters is suggested in the CDM User's Guide. The radial integral is handled in the code in a manner equivalent to dividing the integral into three parts, corresponding to the three distance ranges given above, and applying the trapezoidal rule separately to each part. The upper index, M, is determined by the distance from the receptor to the farthest point of the area emission grid or the maximum allowed number of arcs (100 in the current version), whichever gives the smaller distance.

The angles θ_j, j=1 to N, in Eqn. 6 are determined from the compass direction which defines the sector under consideration, and represent the angular coordinates of the points on each arc at which the emission rate Q(r,θ) is evaluated. The number of intervals into which each arc is divided is given by the user-supplied parameter DINT, and the number of points used on each arc is given by N=DINT + 1. The angular increment Δθ is given by

$$\Delta\theta = \frac{2\pi}{16}\,\frac{1}{\mathrm{DINT}} \text{ radians.} \qquad (8)$$

A value of 4 is suggested in the User's Guide as being a typical value of DINT. The maximum allowed value is 20.

The determination of the quantities Q(r,θ) in Eqn. 6 requires some discussion. In the simplest case, the emission grid square in which each point falls is identified and the appropriate emission rate per unit area used. If, however, the sampling point falls within 1×10^{-4} emission grid units of the boundary between two adjacent squares, the average emission rate per unit area for those two squares is used at that point. If the sampling point falls within 1×10^{-4} emission grid units of both a horizontal and a vertical boundary, i.e., very close to the intersection of four grid squares, the average emission rate for the four squares involved is used at that point.

Thus, conceptually the CDM algorithm consists of the following steps:

1. Evaluate the average area source emission rate per unit area within concentric annular strips of width Δr centered on radial distances given by Eqn. 7. The average is approximated by the average along the central arc of each strip.
2. Multiply the average emission rate per unit area for each strip by the area of the strip and by a distance-dependent meteorological factor which accounts for transport and dispersion. Each such product gives the contribution from that strip to the pollutant concentration at the receptor.
3. Sum over all strips to obtain the total area source contribution from that sector.
4. Sum over all sectors.

As described briefly in Sec. 2.2, the procedure by which individual area source contributions are estimated consists of 1) an evaluation of the contribution made by each emission grid square to the total for each arc and 2) the summation for each user-defined area source of all such contributions.

Two types of error arising from the area source algorithm may be present in the individual area source contributions given in the list. The first is due to inaccuracy in the value of the average emission rate used to calculate the contribution from a given strip. Errors in this quantity arise from a combination of significant variability in emission rate from one grid square to the next and too low a density of sampling points. If all area sources in the grid emit pollutant at the same rate per unit area, the algorithm will always obtain the correct average emission rate for any strip which lies wholly within the grid. In this case, the first type of error does not occur. If the application in which CDMQC is being used is consistent with the implicit assumption of relatively uniform area emissions, this type of error will be of minimal importance.

The second type of error in the individual area source contributions exists even if the average emission rate for each strip has been correctly evaluated, and arises from the way in which the relative weight of each grid square is determined. If all grid squares have the same emission rate, the relative weighting of their contributions does not affect the numerical value of the average. However, the individual contributions do depend on the weights and may be in error if the weights are inaccurate. In cases involving non-uniform emissions, the error made in calculating the average may in fact be thought of as arising from inaccuracies in the relative weights.

An admittedly extreme example may clarify the situation. Suppose a value of 1 is used for DINT. In this case, the average emission rate for each strip is obtained as an average of the two values corresponding to the grid square(s) in which the two end points of the central arc happen to fall. Suppose the orientation of the emission grid is such that one axis is perpendicular to the wind direction and the other is parallel. In this case, if the distance from the receptor to the arc is greater than about 1.31 grid lengths, the separation between the two end points is sufficiently large that it is possible to completely miss a grid square located directly upwind of the receptor. If the emission rate is the same for all grid squares, the average emission rate and the total contribution for each strip will be numerically correct, but beyond 1.31 grid lengths the total contribution will be equally divided between the two squares detected by the program. The middle square will be reported as having made no contribution at all. Figure A.1 illustrates the possibilities of angular and radial skipover, and part (a) of that figure illustrates the example just described.

A relatively accurate determination of individual area source contributions requires a relatively accurate determination of the weight with which each square contributes to each strip. The accuracy of this determination is directly related to the density of sampling points, which is in turn related to the values of DELR (or more precisely, the ratio of DELR to the grid spacing) and DINT, as well as to the distance of the strip in question from the receptor. More accurate results can be expected for those area sources near the receptor, but it may be very difficult to get accurate results for sources farther away.

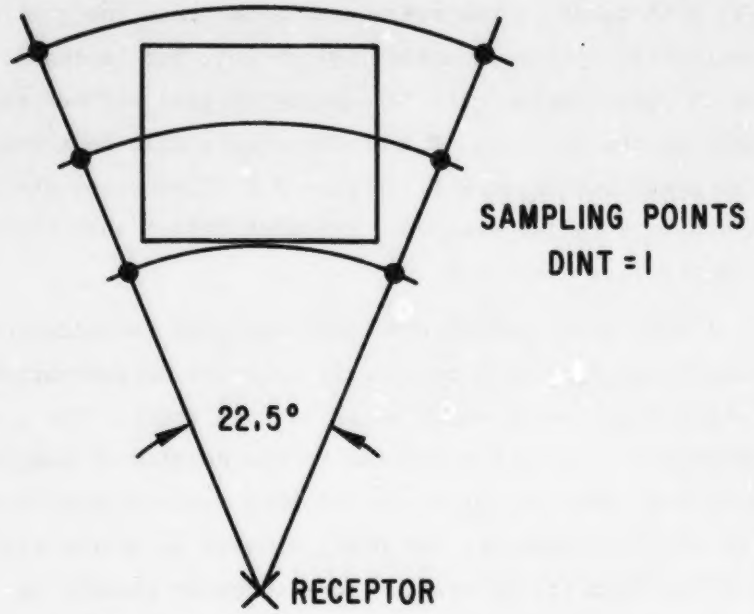
Three types of phenomena attributable to the distribution of sampling points have been observed in test cases. The most obvious problem is that of skipover, the failure to detect a grid square at all. Table A.1 shows in three cases the number of layers of grid squares that are encountered before reaching a layer in which at least one square is skipped entirely, for various values of DINT and the ratio DELR/TXX (TXX is the user-input parameter giving the width of a basic emission grid square in meters).

These test cases correspond to the following combinations of receptor location and wind direction:

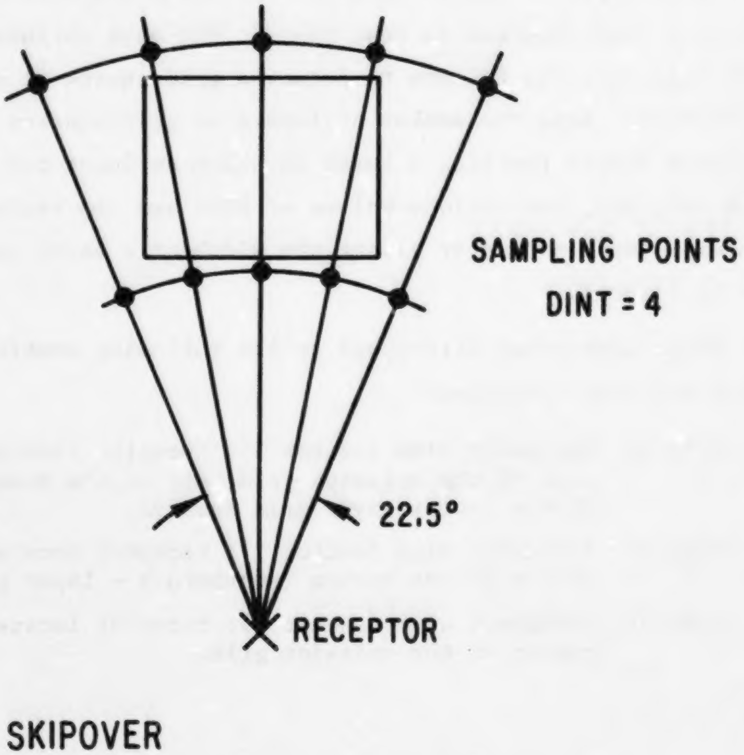
Case 1: Northerly wind (sector 1); receptor located on the southern edge of the emission grid, and on the boundary between two of the bottom-layer grid squares.

Case 2: Northerly wind (sector 1); receptor located in the center of one of the bottom (southern) - layer grid squares.

Case 3: Northeast wind (sector 3); receptor located at the southwest corner of the emission grid.


SAMPLING POINTS
DINT = 1
22.5°
RECEPTOR

a) ANGULAR SKIPOVER


SAMPLING POINTS
DINT = 4
22.5°
RECEPTOR

b) RADIAL SKIPOVER

Fig. A.1. Angular and Radial Skipover

Table A.1. Number of Layers of Emission Grid Squares Before the Onset of Skipover

	Case 1			Case 2			Case 3	
	DELR/TXX			DELR/TXX			DELR/TXX	
DINT	0.0625	0.125	0.250	0.0625	0.125	0.250	0.125	0.250
3	--	10	10	--	--	--	5	4
4	15[a]	15	15	14	13	13	8	7
5	--	15	15	--	--	--	10	5
7	--	21	20	--	--	--	15	9
10	15[a]	30	30	15	28	28	20	16
15	--	39[a]	41	--	--	--	27[a]	14
20	15[a]	39[a]	>49[b]	16[a]	40[a]	47	27[a]	21

[a] At the limit imposed by the finite range of radial integration.

[b] At the limit imposed by the finite size of the test emission grid.

In each case, the emission grid consisted of a 49 x 49 array of 1000 meter squares all having the same emission rate. A single stability class (no. 4) and wind speed class (no. 3) were used.

The general conclusion to be drawn from the table is that to avoid the skipover problem altogether, one must generally go to smaller radial and angular increments. However, as indicated elsewhere, the use of smaller radial increments may result in the termination of the radial integration due to computer storage restrictions before the far edge of the emission grid is reached, with the corresponding omission of a significant part of the total area source contribution. Table A.2 gives the effective maximum range of the radial integral obtainable with three values of DELR, corresponding to the restriction that the total number of arcs that can currently be handled is 100, and the corresponding percent of the total area source contribution obtained in test case number one.

Table A.2. Dependence of Effective Range and Example Percent of Total Contribution on DELR Value

DELR (meters)	Range (km)	Percent of Total Contribution Test Case 1
250.0	89.0	100.0
125.0	39.5	86.2
62.5	14.8	52.5

A second phenomenon observed in the tests that were run is that the calculated contributions from adjacent grid squares having the same emission rates were often in the ratio of small whole numbers, and not nearly identical as one might expect. The ratio of contributions from adjacent grid squares reflects the relative number of times that the two grid squares were sampled. Examples of this type of situation in which the ratio is nearly that of small whole numbers are quite easy to produce. The problem can be alleviated near the receptor by using smaller radial and angular increments, but the problem always appears again farther away.

The third phenomenon is associated with the first and is in a sense complementary to it. As pointed out earlier, it is possible to obtain the correct average emission rate for a given strip without having even detected many of the grid squares which in reality do contribute. The entire calculated contribution from that strip is allocated among only those squares which are actually detected. As a result, the squares which are missed are assigned no contribution and those which are found are assigned a larger contribution than they deserve. At large enough distances, for a conservative pollutant, the contribution from those squares which are found levels off to a constant value rather than decreasing with distance as would be the case if the allocation were correct.

In order to have a basis for providing guidelines for use, CDMQC area source contribution values were compared against values calculated using exactly the same algorithm as CDMQC except that the relative weight of each grid square to each strip was accurately evaluated. This comparison was made only for test cases 1 and 2 described previously, and the results are shown in Fig. A.2(a)-(f) in the form of percent error of individual contributions, defined by

$$\text{percent error} = \frac{(\text{CDMQC value}) - (\text{more accurate value})}{(\text{more accurate value})} \times 100. \quad (9)$$

Results are presented for all combinations of DELR/GRID SPACING values of 0.0625, 0.125, and 0.250 and DINT values of 4, 10 and 20. These results should be considered as illustrative only, but should be useful to the user in providing guidance for the selection of DELR and DINT values for a given application.

Each box in the figures represents one emission grid square, and only the first ten rows of squares upwind of the receptor are shown. In addition, due to the position of the receptors, only part of each of the first ten rows need be considered, the omitted results being identical to those which are given, by reason of symmetry. In parts (a), (b) and (c) for example, only the top half of the results are shown, the bottom half being a mirror image of the top. In parts (d), (e), and (f) the top two rows of boxes should be reflected below the bottom row, making five rows in all.

The three numbers appearing in each box correspond to the three values of DINT which were considered: the top number corresponds to DINT = 20, the middle to DINT = 10, and the bottom to DINT = 4. The six parts of the figure correspond to three values of DELR/GRID SPACING at each of two receptor positions, as indicated on the figures.

In addition, a somewhat similar comparison was made using results based upon the test example presented in Appendix C. Ten receptors and seventeen area sources were considered. Initially, values of DELR=250m and DINT=4 were used, although values of DELR=100m and DINT=10 are used in Appendix C in accordance with the guidelines presented in Section 2.2. Table A.3 presents the results of a comparison between the two sets of individual area source SO_2 contributions. The table entries represent the approximate percent change that occurred in individual contributions to the estimated SO_2 concentration upon changing the DELR and DINT values from 250m and 4 to 100m and 10. It should be pointed out that the largest percentage changes in Table A.3 are usually associated with very small contributions. For example, the 50% changes observed for receptor no. 5 with area source 4A and for receptor no. 7 with area source 13A represent increases from 0.02 to 0.03 micrograms/cubic meter. An entry of 0 (zero) in Table A.3 indicates that the difference in the two indicated values was less than 0.01 micrograms/cubic meter. A comparison of the two values of the total area source contribution to the estimated SO_2 concentration is also presented on the last line of Table A.3, again in terms of percent change.

← WIND DIRECTION

1	2	3	4	5	6	7	8	9	10
					+ 16.1 + 18.3 +195.8	- 0.4 +10.2 +11.3	+ 0.1 - 7.3 -22.7	- 2.3 - 2.6 -38.7	- 4.5 + 6.1 -46.9
+ 1.5 + 1.4 + 1.1	- 1.6 - 1.5 - 1.3	+ 1.5 + 1.4 + 1.1	- 1.5 - 1.4 - 1.2	+ 2.6 + 2.6 + 2.3	- 2.8 - 3.0 - 19.5	- 1.8 - 4.7 - 4.7	- 0.5 + 3.1 +10.8	- 0.7 - 0.4 +24.3	+ 1.7 - 7.4 +39.1

Receptor at lower left corner of leftmost emission grid square

DELR/GRID SPACING = 0.0625

Top: DINT = 20   Middle: DINT = 10   Bottom: DINT = 4

Fig. A.2(a) Percent Error in Individual Emission Grid Square Contributions

← WIND DIRECTION

1	2	3	4	5	6	7	8	9	10
					+ 12.6 + 14.7 + 186.8	+ 7.5 + 29.1 + 7.5	+ 7.9 - 7.5 - 22.9	- 3.6 - 3.8 - 39.5	- 5.7 + 4.8 - 47.6
+ 3.6 + 3.4 + 2.8	- 3.2 - 3.1 - 2.6	+ 3.1 + 2.9 + 2.4	- 2.9 - 2.7 - 2.3	+ 5.8 + 5.6 + 5.1	- 3.2 - 3.6 - 20.2	- 6.5 - 12.5 - 5.7	- 5.6 + 1.9 + 9.8	- 1.9 - 1.5 + 23.2	+ 0.6 - 8.3 + 37.9

Receptor at lower left corner of leftmost emission grid square

DELR/GRID SPACING = 0.125

Top: DINT = 20 Middle: DINT = 10 Bottom: DINT = 4

Fig. A.2(b) Percent Error in Individual Emission Grid Square Contributions

← WIND DIRECTION

1	2	3	4	5	6	7	8	9	10
					+ 72.4 + 15.0 + 187.4	+ 4.8 + 25.7 + 4.8	+ 12.2 - 3.8 - 19.8	+ 0.4 + 11.6 - 44.2	- 7.9 + 2.3 - 48.9
+ 7.9 + 7.5 + 6.2	- 6.4 - 6.1 - 5.3	+ 6.5 + 6.2 + 5.2	- 6.0 - 5.7 - 4.8	+ 12.3 + 12.0 + 11.1	- 10.0 - 5.0 - 22.0	- 10.0 - 15.5 - 8.3	- 2.6 + 5.3 + 14.1	- 18.5 - 25.5 + 12.6	- 1.9 - 10.3 + 35.3

Receptor at lower left corner of leftmost emission grid square

DELR/GRID SPACING = 0.250

Top: DINT = 20 Middle: DINT = 10 Bottom: DINT = 4

Fig. A.2(c) Percent Error in Individual Emission Grid Square Contributions

← WIND DIRECTION

1	2	3	4	5	6	7	8	9	10
								- 7.4 + 85.1 +362.8	- 6.1 - 37.4 + 56.6
			+ 4.9 +12.9 +67.0	- 1.7 - 5.3 -31.6	+ 3.8 + 4.9 - 0.5	- 1.8 - 6.3 + 28.4	+ 3.2 + 11.1 + 19.0	- 2.9 - 6.6 - 22.2	+ 5.8 + 5.8 - 11.8
+ 3.2 + 3.5 + 2.8	- 1.5 - 1.8 - 1.5	+ 1.3 + 1.3 + 1.3	- 2.8 - 4.2 -13.6	- 1.1 + 1.0 +16.2	+ 2.7 + 1.2 + 5.1	- 1.5 + 4.8 - 41.3	- 3.7 - 17.2 - 30.3	- 0.8 - 8.5 - 23.1	- 12.6 + 5.0 - 11.8

Receptor at center of leftmost emission grid square

DELR/GRID SPACING = 0.0625

Top: DINT = 20 Middle = 10 Bottom: DINT = 4

Fig. A.2(d) Percent Error in Individual Emission Grid Square Contributions

← WIND DIRECTION

1	2	3	4	5	6	7	8	9	10
								- 8.6 + 82.9 +357.2	- 7.2 - 38.1 + 54.7
			+ 11.3 + 27.2 + 64.3	+ 0.7 - 6.5 - 32.5	+ 7.7 + 9.5 + 0.8	- 0.4 - 0.7 + 24.9	+ 3.6 + 11.6 + 19.5	- 2.5 - 9.8 - 24.9	+ 4.4 + 4.4 - 13.0
+ 8.6 + 9.1 + 7.6	- 3.7 - 4.4 - 3.8	+ 2.6 + 2.6 + 2.5	- 6.1 - 8.9 - 15.3	- 4.5 - 0.2 + 15.1	+ 7.8 + 5.2 + 10.9	- 8.0 - 7.2 - 40.9	- 2.9 - 16.2 - 28.7	- 11.1 - 11.1 - 24.5	- 13.5 + 4.2 - 11.8

Receptor at center of leftmost emission grid square

DELR/GRID SPACING = 0.125

Top: DINT = 20 Middle: DINT = 10 Bottom: DINT = 4

Fig. A.2(e) Percent Error in Individual Emission Grid Square Contributions

← WIND DIRECTION

1	2	3	4	5	6	7	8	9	10
								- 16.1 + 67.9 + 319.7	- 5.4 - 36.9 + 57.7
			+ 25.8 + 23.8 + 59.7	+ 4.3 + 3.7 - 34.4	- 28.2 - 20.2 - 60.1	- 4.3 - 13.0 + 30.5	+ 2.2 + 10.0 + 17.9	- 10.3 - 10.3 - 25.3	+ 7.1 + 7.1 - 10.8
+ 18.6 + 19.6 + 16.7	- 7.7 - 10.0 - 7.8	+ 5.4 + 5.3 + 5.3	- 12.6 - 12.2 - 18.5	- 10.6 - 9.8 + 12.8	- 19.1 - 23.7 _ 19.7	+ 5.8 + 17.5 - 41.2	- 4.0 - 17.7 - 31.4	+ 10.2 - 5.5 - 21.3	- 11.6 + 6.1 - 11.6

Receptor at center of leftmost emission grid square

DELR/GRID SPACING = 0.250

Top: DINT = 20 Middle: DINT = 10 Bottom: DINT = 4

Fig. A.2(f) Percent Error in Individual Emission Grid Square Contributions

Table A.3. Comparison of Test City Area Source Contribution Results[a]

Area Source ID	Receptor Number									
	1	2	3	4	5	6	7	8	9	10
1A	0	+ 5.0	+20.0	-25.0	0	0	-20.0	0	0	0
2A	0	0	+14.3	0	-11.1	0	0	0	0	0
3A	0	0	-16.7	- 7.1	+ 5.0	0	0	+6.7	+ 3.6	- 1.1
4A	0	0	0	0	+50.0	0	+12.5	+8.3	+14.3	- 4.8
5A	0	0	0	0	0	+25.0	0	-9.1	0	+16.7
6A	0	- 1.3	- 9.1	+20.0	0	0	0	0	0	0
7A	- 1.5	- 1.8	- 1.5	+ 1.9	0	- 1.1	0	-2.7	- 1.1	+ 2.1
8A	0	+14.3	+16.7	0	+ 7.1	+ 5.9	+ 3.3	0	- 1.0	0
9A	-12.5	0	0	+25.0	- 5.9	-13.3	0	0	0	+ 2.9
10A	- 2.7	0	0	0	0	0	0	0	0	0
11A	0	+ 5.9	+ 4.8	+11.1	+ 5.1	- 5.6	- 0.9	-6.3	- 3.0	+ 7.1
12A	+16.7	0	+ 8.3	-14.3	+11.8	0	- 3.0	0	0	0
13A	0	0	0	0	-25.0	0	+50.0	0	0	0
14A	0	+33.3	0	0	0	0	0	0	0	0
15A	+10.0	-12.5	0	- 0.6	0	0	0	0	0	0
16A	-11.1	0	- 4.3	0	0	0	0	0	0	0
17A	+33.3	+25.0	0	-11.1	-12.5	+33.3	0	0	+16.7	0
Total[b]	0	- 2.6	0	0	0	- 1.9	- 2.0	0	- 1.8	0

---

[a] Table entries represent the approximate percent change in the SO_2 contribution from each area source at each receptor in going from DELR=250m, DINT=4 to DELR=100m, DINT=10 evaluated as described in the text.

[b] Entries in this row represent the percent change in the total area source SO_2 contribution at each receptor, evaluated as described in the text.

APPENDIX B. STATISTICAL INFORMATION FROM THE CALIBRATION PROCEDURE

The process of model calibration involves doing a linear least-squares regression analysis of observed against calculated concentration values for a given set of receptors. The purpose of this appendix is to present the formulas used in the CDM calibration routine and to define briefly the various quantities which are printed by the program upon completion of the calibration calculations.

Equations are presented for the general case in which the regression line between a set of values y_i ($i = 1,2....N$) and a different set x_i ($i = 1, 2 .... N$) is to be determined. For calibration purposes, the set y_i represents the set of observed concentration values for a given pollutant at N different receptor locations, and the set x_i represents the corresponding set of calculated values. Linear regression of the set y_i against the set x_i involves the determination of the regression coefficients A and B, which are defined such that the regression line

$$\hat{y} = A + Bx \tag{1}$$

represents the straight line which best fits, in a least-squares sense, the plot of the y_i values against the x_i values. In Eq. 1, $\hat{y}$ represents the value of y which is predicted for a given value of x on the basis of the regression line, and is not necessarily equal to the observed value for that same x because of both measurement errors and model approximations. It can be shown (see for example Draper and Smith (1966) or Mood and Graybill (1963)) that the regression coefficients determined from specific sets of observed and calculated values are given by Eqns. 2 and 3:

$$B = \frac{\sum_{i=1}^{N} (x_i-\overline{x})(y_i-\overline{y})}{\sum_{i=1}^{N} (x_i-\overline{x})^2} \tag{2}$$

and

$$A = \overline{y} - B\overline{x} \tag{3}$$

with

$$\overline{x} = \frac{1}{N} \sum_{i=1}^{N} x_i \tag{4}$$

and

$$\bar{y} = \frac{1}{N} \sum_{i=1}^{N} y_i \qquad (5)$$

To simplify the notation used in writing further equations, we will henceforth omit the summation limits; the summation limits implicit in all subsequent equations are 1 and N, exactly as in Eqns. 2, 4 and 5.

In evaluating B, it is convenient for computational reasons to use the equivalent formula

$$B = \frac{\Sigma x_i y_i - N\bar{x}\,\bar{y}}{\Sigma x_i^{\,2} - N\bar{x}^2} \qquad (6)$$

The sample correlation coefficient is defined by:

$$R = \frac{\Sigma(x_i - \bar{x})\,(y_i - \bar{y})}{\left[\,\Sigma(x_i - \bar{x})^2 \;\; \Sigma(y_i - \bar{y})^2\,\right]^{1/2}} \qquad (7)$$

although it is again more convenient computationally to use a different but equivalent formula:

$$R = \frac{\Sigma x_i y_i - N\bar{x}\cdot\bar{y}}{\left[(\Sigma x_i^{\,2} - N\bar{x}^2)\,(\Sigma y_i^{\,2} - N\bar{y}^2)\right]^{1/2}} \qquad (8)$$

The correlation coefficient is a measure of the degree to which the quantities x and y are linearly related, and is rather closely related to the slope of the regression line as can be seen by a comparison of Eqns. 2 and 7 (or 6 and 8). Furthermore, the square of the correlation coefficient is a measure of the extent to which the variation in the observed values about the mean is explained by the variation in the calculated values about their mean. The square of the correlation coefficient is printed under the heading "R-SQUARED."

An estimate can be made of the uncertainty in the specific slope and intercept values obtained in any given analysis. The sample variances of the slope and intercept are given by:

$$\text{Variance of Slope} = \frac{s^2}{\Sigma(x_i - \overline{x})^2} \qquad (9)$$

$$\text{Variance of Intercept} = \frac{s^2\ \Sigma x_i{}^2}{N\ \Sigma(x_i - \overline{x})^2} \qquad (10)$$

The quantity s^2 is defined below. A convenient measure of the uncertainty in the slope and intercept estimates is the standard deviation for each, the standard deviations being simply the square roots of the corresponding variances. The standard deviations are printed next to the estimated values in the regression analysis output.

The total sum of squares of observed values about the mean,

$$\text{Total Sum of Squares} = \Sigma\,(y_i - \overline{y})^2 \qquad (11)$$

may be written as the sum of two terms: 1) the sum of squares due to regression:

$$\text{Regression Sum of Squares} = \Sigma\,(\hat{y}_i - \overline{y})^2 \qquad (12)$$

with

$$\hat{y}_i = A + Bx_i, \qquad (13)$$

and 2) the sum of squares due to deviations of observed values about the regression line:

$$\text{Deviations Sum of Squares} = \Sigma\,(y_i - \hat{y}_i)^2 \qquad (14)$$

The ratio of the deviations sum of squares to the total sum of squares can be shown to be equal to the square of the correlation coefficient, and the significance of this ratio was mentioned earlier. All three of these quantities together with their respective numbers of degrees of freedom are printed in the analysis of variance table in the output from the CDMQC regression routine. The number of degrees of freedom are 1, N-2, and N-1 for regression, deviations and total sum of squares, respectively.

Two other quantities are of interest: the mean square due to regression, equal to the regression sum of squares divided by its degrees of freedom and the mean square due to deviations about regression, equal to the deviations sum of squares divided by its degrees of freedom. The latter quantity is denoted by s^2

$$s^2 = \frac{\text{Deviations Sum of Squares}}{N - 2}, \qquad (15)$$

s^2 is an unbiased estimate of the variance of the deviations of the y_i about the regression line only when the true relationship between the y_i and the x_i is linear and when the random deviations are distributed normally with zero mean. Both mean square values are printed in the regression output.

The observed mean concentration $(\bar{y})$ and the calculated mean concentration $(\bar{x})$, given by Eqns. 5 and 4 respectively, are also printed.

From the statistical output just described, the user may perform additional calculations relating to the regression analysis if he so desires. For example, he may

1) determine confidence intervals for the estimated slope and intercept values,
2) perform an F-test to test the significance of the regression, and
3) determine confidence intervals about specific $\hat{y}$ values.

In order to do the latter calculation, the user needs the value of the quantity $\Sigma\,(x_i - \bar{x})^2$; this quantity is not explicitly printed out, but is equal to the ratio of the mean square due to deviations about regression and the variance of the slope:

$$\Sigma\,(x_i - \bar{x})^2 = \frac{s^2}{(\text{Standard deviation of slope})^2} \qquad (16)$$

The procedures for doing the calculations just listed are given in Draper and Smith (1966) or Mood and Graybill (1963).

REFERENCES: APPENDIX B

Draper, N.R. and Smith, H., Applied Regression Analysis, John Wiley & Sons, Inc., New York (1966).

Mood, A.M. and Graybill, F.A., Introduction to the Theory of Statistics, 2nd Edition, McGraw-Hill Book Co., New York (1963).

APPENDIX C. TEST EXAMPLE

In this appendix, the use of CDMQC in a hypothetical test situation is described in sufficient detail so as to illustrate the format for the input data and the various types of output that the user may obtain.

C.1. GENERAL DESCRIPTION

The test situation that is used in this appendix was adapted from the AQDM "TEST CITY" example described in the AQDM user's manual. This example, although hypothetical and not as complex as is usually encountered in practice, nevertheless provides a more realistic and interesting test of CDMQC's capabilities than does the test case which appears in the CDM User's Guide. Fig. C.1 shows the map of TEST CITY and the locations of all sampling stations, point and area sources used in this adaptation.

C.2 DETAILED INPUT AND OUTPUT LISTINGS

Fig. C.2 shows the complete input data set in card image format for the TEST CITY example. It should be pointed out that all input was provided on punched cards (IRD=5).

Fig. C.3 shows the entire printed output obtained from the given input data set, and Fig. C.4 shows the punched output in card image form obtained from the same run.

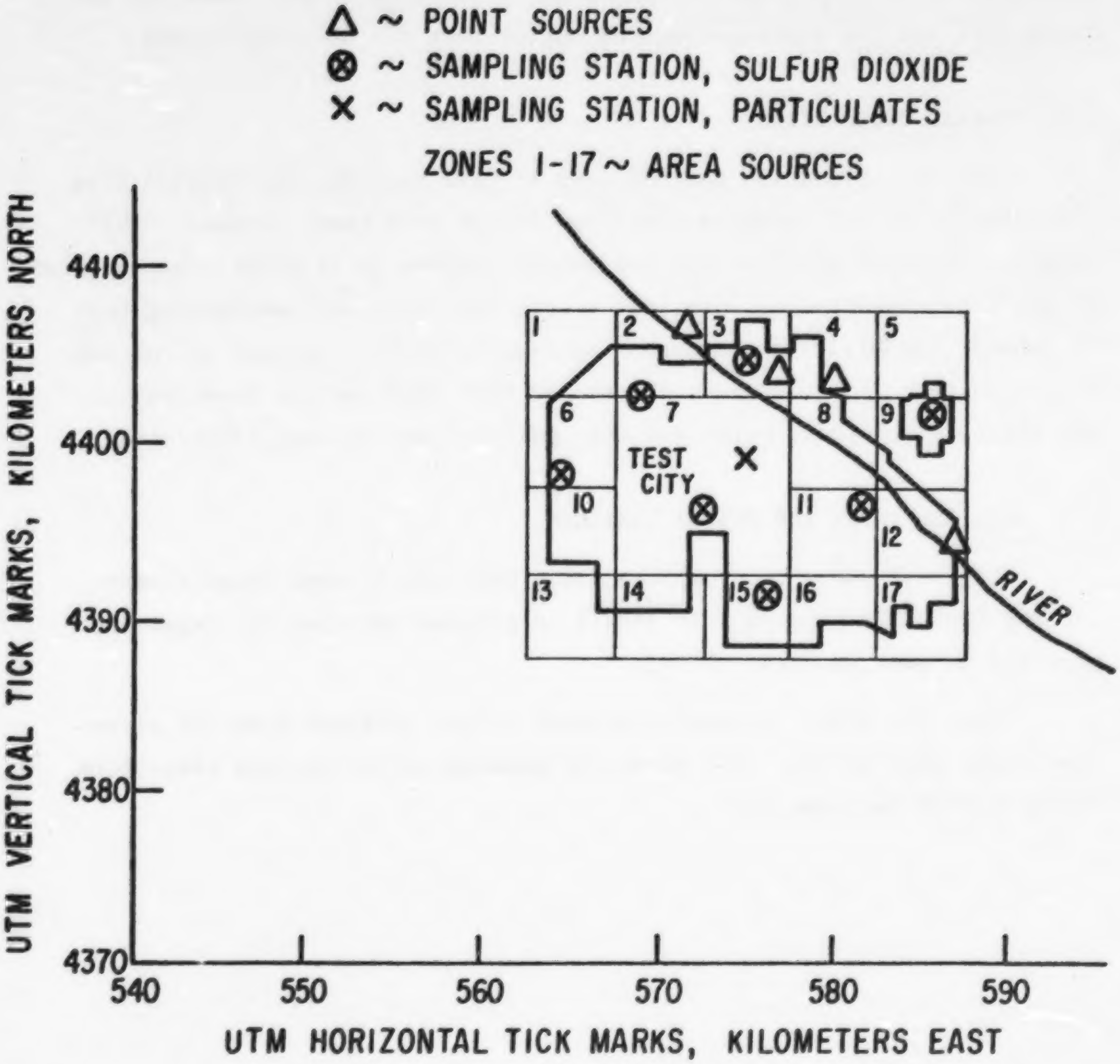

△ ~ POINT SOURCES
⊗ ~ SAMPLING STATION, SULFUR DIOXIDE
X ~ SAMPLING STATION, PARTICULATES
ZONES 1-17 ~ AREA SOURCES
UTM VERTICAL TICK MARKS, KILOMETERS NORTH
4410
4400
4390
4380
4370
540
550
560
570
580
590
UTM HORIZONTAL TICK MARKS, KILOMETERS EAST
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
TEST CITY
RIVER

Fig. C.1. TEST CITY Base Map

```
                                        AQDM TEST CITY
                                                                       1.          1.
       A1  A2  P1  P2  1              5    6    7
         8    2          1.           1. SO2  PART  1.0 8.024.0  4.0 8.024.0
       100.    5. 1000. 1000.   100. 562.54387.5  550.4372.5 1000.   15. 5000.
        10.    1.    1.   30.    30.   30.   30.   30.   30.999999999999
INSERT 16 BLANK CARDS HERE
        .000500.000500.0     .0     .0     .0
        .0     .0     .0     .0     .0     .0
        .0     .000500.0     .0     .0     .0
        .000500.0     .0     .0     .0     .0
        .000900.000500.000500.0     .0     .0
        .000900.0     .0     .0     .0     .0
        .000900.000500.0     .0     .0     .0
        .0     .0     .0     .0     .0     .0
        .0     .0     .0     .0     .0     .0
        .0     .0     .0     .0     .0     .0
        .0     .0     .0     .0     .0     .0
        .000900.0     .0     .0     .0     .0
        .0     .000500.0     .0     .0     .0
        .000500.0     .0     .0     .0     .0
        .0     .0     .0     .0     .0     .0
        .0     .0     .0     .0     .0     .0
        .000500.0     .003200.0     .0     .0
        .0     .000500.000900.0     .0     .0
        .0     .0     .000900.0     .0     .0
        .000900.000900.004600.0     .0     .0
        .001800.002600.004100.000500.0     .0
        .0     .003700.004600.0     .0     .0
        .001400.003200.002800.0     .0     .0
        .0     .002800.000900.0     .0     .0
        .0     .000900.000900.0     .0     .0
        .0     .001800.000900.0     .0     .0
        .0     .001800.000900.0     .0     .0
        .000500.001400.000900.0     .0     .0
        .0     .001400.000900.0     .0     .0
        .000500.000500.000900.0     .0     .0
        .0     .000900.000500.0     .0     .0
        .0     .001400.001400.0     .0     .0
        .0     .001080.031560.022960.002220.0
        .0     .000540.008040.009420.001680.0
        .0     .000540.006360.008880.000300.0
        .0     .002220.006360.006360.000300.0
        .0     .003360.008880.008280.003300.000840
        .0     .001680.006060.030420.006660.000840
        .0     .000840.013020.024600.003060.000300
        .0     .001080.010500.014640.001680.0
        .0     .000300.008880.018000.001380.0
        .0     .000840.005280.005280.0     .0
        .0     .001080.001080.0     .0     .0
        .0     .000540.005280.000300.0     .0
        .0     .002460.007740.004140.0     .0
        .0     .002220.009420.006660.001080.0
        .0     .001380.014640.009660.001680.0
        .0     .001680.018000.019620.001380.0
        .0     .000720.021040.015320.001480.0
        .0     .000360.005360.006280.001120.0
        .0     .000360.004240.005920.000200.0
        .0     .001480.004240.004240.000200.0
        .0     .002240.005920.005520.002200.000560
        .0     .001120.004040.020280.004440.000560
        .0     .000560.008680.016400.002040.000200
```

Figure C.2. TEST CITY Input Dataset

```
               .0     .000720.007000.009760.001120.0
               .0     .000200.005920.012000.000920.0
               .0     .000560.003520.003520.0      .0
               .0     .000720.000720.0      .0     .0
               .0     .000360.003520.000200.0      .0
               .0     .001640.005160.002760.0      .0
               .0     .001480.006280.004440.000720.0
               .0     .000920.009760.006440.001120.0
               .0     .001120.012000.013080.000920.0
               .005100.012400.021200.0      .0     .0
               .000500.002800.004600.0      .0     .0
               .000900.005100.002800.0      .0     .0
               .003200.007800.004100.0      .0     .0
               .010600.016100.005500.0      .0     .0
               .005500.016100.012400.0      .0     .0
               .001400.006900.004600.0      .0     .0
               .000900.005100.005100.0      .0     .0
               .002800.004600.002300.0      .0     .0
               .005100.006500.0      .0     .0     .0
               .000900.003700.0      .0     .0     .0
               .001800.003700.0      .0     .0     .0
               .001800.006500.000500.0      .0     .0
               .035500.012000.003700.0      .0     .0
               .008800.011100.003700.0      .0     .0
               .003200.011500.006900.0      .0     .0
         568.5 4403.4          1365.00  527.63   150.
         584.2 4391.6          1580.36   789.6    90.   8.7    15.2   149.   .0001
         577.0 4401.1           221.76   34.13    30.    .7    17.8   515.
         574.1 4401.5           110.25   54.08    23.   1.4    15.2   260.
    INSERT ONE BLANK CARD HERE
         562.5 4402.5  5000.    1.37     1.68
         567.5 4402.5  5000.    1.26     1.79
         572.5 4402.5  5000.    5.25     3.99    10.
         577.5 4402.5  5000.    1.47    13.13
         582.5 4402.5  5000.     1.2     1.58
         562.5 4397.5  5000.    2.62     1.47    10.
         567.5 4392.5 10000.   32.66    21.11    15.
         577.5 4397.5  5000.    5.46     3.99    10.
         582.5 4397.5  5000.    6.62     5.78    10.
         562.5 4392.5  5000.    2.63     1.16    10.
         577.5 4392.5  5000.    7.88     5.15    20.
         582.5 4392.5  5000.    5.25     3.68    10.
         562.5 4387.5  5000.    2.73     1.37
         567.5 4387.5  5000.    2.42     1.89    10.
         572.5 4387.5  5000.    5.36     4.10    10.
         577.5 4387.5  5000.    5.57     3.89    10.
         582.5 4387.5  5000.    2.64     1.47    10.
    INSERT ONE BLANK CARD HERE
         562.0  4395.7                  10.     6. 1.81  1.70   1   3            TCC1
         566.1  4400.0                  18.    10.                2              TC02
         570.0  4393.2                  12.     8. 1.83               1          TC03
         573.9  4388.9                  14.    11.       1.65         2          TC04
         572.5  4396.7                          9.       1.72   1 2 2 2          TC05
         572.4  4402.2                  50.    26.              1                TC06
         579.0  4394.0                  20.     8.                               TC07
         583.0  4399.2                  16.     7.              1   3            TC08
         577.5  4397.5                                          1 2              TC09
         576.0  4403.0                                          1 2 1            TC10
```

Figure C.2. TEST CITY Input Dataset, continued.

```
                           C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                  AQDM TEST CITY
                                                    RUN   100

POLLUTANTS TO BE MODELED:

    1) SO2
    2) PART

OPERATING PARAMETERS:

    X-MINIMUM OF AREA EMISSION INVENTORY MAP GRID (XG) ..............................       5.625000E 02
    Y-MINIMUM OF AREA EMISSION INVENTORY MAP GRID (YG) ..............................       4.387500E 03

    WIDTH OF BASIC AREA SOURCE SQUARE (TXX) .........................................       5.000000E 03 METERS

    INITIAL SIGMA Z (METERS) FOR AREA SOURCES (SZA):

         STABILITY CLASS:     1 .....................................................       3.000000E 01
                              2 .....................................................       3.000000E 01
                              3 .....................................................       3.000000E 01
                              4 .....................................................       3.000000E 01
                              5 .....................................................       3.000000E 01
                              6 .....................................................       3.000000E 01

    NUMBER OF SUBSECTORS CONSIDERED IN A 22.5 DEGREE SECTOR (DINT) ..................       1.000000E 01
    ANGULAR WIDTH OF A SUBSECTOR (THETA) ............................................       2.250000E 00 DEGREES

    INITIAL RADIAL INCREMENT (DFLR) .................................................       1.000000E 02 METERS

    RATIO OF EMISSION GRID TO MAP GRID (RAT) ........................................       5.000000E 00
    GRID CONVERSION FACTOR (CV) .....................................................       1.000000E 03

MISCELLANEOUS METEOROLOGICAL DATA:

    AVERAGE AFTERNOON MIXING HEIGHT (HT) ............................................       1.000000E 03 METERS
    AVERAGE NOCTURNAL MIXING HEIGHT (HMIN) ..........................................       1.000000E 02 METERS
    MEAN ATMOSPHERIC TEMPERATURE (TOA) ..............................................       1.500000E 01 DEGREES CELSIUS

    DECAY HALF LIFE FOR SO2  (GB(1)) ................................................       9.999990E 05 HOURS
    DECAY HALF LIFE FOR PART (GB(2)) ................................................       9.999990E 05 HOURS

RATIO (YD) OF AVERAGE DAYTIME EMISSION RATE TO THE 24-HOUR EMISSION RATE AVERAGE ....       1.000000E 00
RATIO (YN) OF AVERAGE NIGHTTIME EMISSION RATE TO THE 24-HOUR EMISSION RATE AVERAGE ..       1.000000E 00

BACKGROUND CONCENTRATION (BKGR), ARITHMETIC MEAN, FOR:

    SO2 .............................................................................       1.000000E 00 MICROGRAMS/CU. METER
    PART ............................................................................       1.000000E 00 MICROGRAMS/CU. METER
```

Figure C.3. TEST CITY Printed Output

```
                     C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                               AQDM TEST CITY
                                                RUN    100

ANY CULPABILITY LIST(S) WILL INDIVIDUALLY LIST SOURCES CONTRIBUTING GREATER
THAN OR EQUAL TO  0.0 % (CTCP) OF TOTAL CALIBRATED CONCENTRATION

(IOCAL=2) REGRESSION EQUATION CONSTANTS WILL BE DETERMINED BASED ON COMPUTED AND OBSERVED CONCENTRATIONS FOR
          FIRST SET OF   8 RECEPTORS INPUT;  IF COMPUTED CORRELATION COEFFICIENT LESS THAN THEORETICAL VALUE,
          FOR EITHER POLLUTANT, DEFAULT REGRESSION COEFFICIENT VALUES (INTERCEPT=0, SLOPE=1), TOGETHER WITH INPUT
          BACKGROUND LEVELS, WILL BE USED TO CALIBRATE;  IF COMPUTED CORRELATION COEFFICIENT GREATER THAN OR
          EQUAL TO THEORETICAL VALUE, FOR BOTH POLLUTANTS, COMPUTED CONSTANTS WILL BE USED TO CALIBRATE.

LARSEN'S STATISTICAL MODEL WILL BE APPLIED FOR THE FOLLOWING AVERAGING TIMES (PAV):

   SO2
      1.0 HOURS
      8.0 HOURS
     24.0 HOURS
   PART
      4.0 HOURS
      8.0 HOURS
     24.0 HOURS
```

Figure C.3. TEST CITY Printed Output, continued.

```
                         C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                              AQDM TEST CITY
                                               RUN    100

                                    METEOROLOGICAL JOINT FREQUENCY FUNCTION

STABILITY CLASS 1                                               W I N D   S P E E D   C L A S S

   WIND DIRECTION     SECTOR                1           2           3           4           5           6

        N               1                 0.0         0.0         0.0         0.0         0.0         0.0
        NNE             2                 0.0         0.0         0.0         0.0         0.0         0.0
        NE              3                 0.0         0.0         0.0         0.0         0.0         0.0
        ENE             4                 0.0         0.0         0.0         0.0         0.0         0.0
        E               5                 0.0         0.0         0.0         0.0         0.0         0.0
        ESE             6                 0.0         0.0         0.0         0.0         0.0         0.0
        SE              7                 0.0         0.0         0.0         0.0         0.0         0.0
        SSE             8                 0.0         0.0         0.0         0.0         0.0         0.0
        S               9                 0.0         0.0         0.0         0.0         0.0         0.0
        SSW            10                 0.0         0.0         0.0         0.0         0.0         0.0
        SW             11                 0.0         0.0         0.0         0.0         0.0         0.0
        WSW            12                 0.0         0.0         0.0         0.0         0.0         0.0
        W              13                 0.0         0.0         0.0         0.0         0.0         0.0
        WNW            14                 0.0         0.0         0.0         0.0         0.0         0.0
        NW             15                 0.0         0.0         0.0         0.0         0.0         0.0
        NNW            16                 0.0         0.0         0.0         0.0         0.0         0.0

STABILITY CLASS 2                                               W I N D   S P E E D   C L A S S

   WIND DIRECTION     SECTOR                1           2           3           4           5           6

        N               1                 0.000500    0.000500    0.0         0.0         0.0         0.0
        NNE             2                 0.0         0.0         0.0         0.0         0.0         0.0
        NE              3                 0.0         0.000500    0.0         0.0         0.0         0.0
        ENE             4                 0.000500    0.0         0.0         0.0         0.0         0.0
        E               5                 0.000900    0.000500    0.000500    0.0         0.0         0.0
        ESE             6                 0.000900    0.0         0.0         0.0         0.0         0.0
        SE              7                 0.000900    0.000500    0.0         0.0         0.0         0.0
        SSE             9                 0.0         0.0         0.0         0.0         0.0         0.0
        S               9                 0.0         0.0         0.0         0.0         0.0         0.0
        SSW            10                 0.0         0.0         0.0         0.0         0.0         0.0
        SW             11                 0.0         0.0         0.0         0.0         0.0         0.0
        WSW            12                 0.000900    0.0         0.0         0.0         0.0         0.0
        W              13                 0.0         0.000500    0.0         0.0         0.0         0.0
        WNW            14                 0.000500    0.0         0.0         0.0         0.0         0.0
        NW             15                 0.0         0.0         0.0         0.0         0.0         0.0
        NNW            16                 0.0         0.0         0.0         0.0         0.0         0.0
```

Figure C.3. TEST CITY Printed Output, continued.

```
                      C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                           AQDM TEST CITY
                                             RUN   100

                                 METEOROLOGICAL JOINT FREQUENCY FUNCTION

STABILITY CLASS 3
                                                          W I N D   S P E E D   C L A S S
   WIND DIRECTION    SECTOR            1           2           3           4           5           6

         N              1          0.000500    0.0         0.003200    0.0         0.0         0.0
         NNE            2          0.0         0.000500    0.000900    0.0         0.0         0.0
         NE             3          0.0         0.0         0.000900    0.0         0.0         0.0
         ENE            4          0.000900    0.000900    0.004600    0.0         0.0         0.0
         E              5          0.001800    0.002800    0.004100    0.0         0.0         0.0
         ESE            6          0.0         0.003700    0.004600    0.000500    0.0         0.0
         SE             7          0.001400    0.003200    0.002800    0.0         0.0         0.0
         SSE            8          0.0         0.002600    0.000900    0.0         0.0         0.0
         S              9          0.0         0.000900    0.000900    0.0         0.0         0.0
         SSW           10          0.0         0.001800    0.000900    0.0         0.0         0.0
         SW            11          0.0         0.001800    0.000900    0.0         0.0         0.0
         WSW           12          0.000500    0.001400    0.000900    0.0         0.0         0.0
         W             13          0.0         0.001400    0.000900    0.0         0.0         0.0
         WNW           14          0.000500    0.000500    0.000900    0.0         0.0         0.0
         NW            15          0.0         0.000900    0.000500    0.0         0.0         0.0
         NNW           16          0.0         0.001400    0.001400    0.0         0.0         0.0

STABILITY CLASS 4
                                                          W I N D   S P E E D   C L A S S
   WIND DIRECTION    SECTOR            1           2           3           4           5           6

         N              1          0.0         0.001080    0.031560    0.022980    0.002220    0.0
         NNE            2          0.0         0.000540    0.008040    0.009420    0.001680    0.0
         NE             3          0.0         0.000540    0.006360    0.008880    0.000300    0.0
         ENE            4          0.0         0.002220    0.006360    0.006360    0.000300    0.0
         E              5          0.0         0.003360    0.008880    0.008280    0.003300    0.000840
         ESE            6          0.0         0.001680    0.006060    0.030420    0.006660    0.000840
         SE             7          0.0         0.000840    0.013020    0.024600    0.003060    0.000300
         SSE            8          0.0         0.001080    0.010500    0.014640    0.001680    0.0
         S              9          0.0         0.000300    0.008880    0.018000    0.001380    0.0
         SSW           10          0.0         0.000840    0.005280    0.005280    0.0         0.0
         SW            11          0.0         0.001080    0.001080    0.0         0.0         0.0
         WSW           12          0.0         0.000540    0.005280    0.000300    0.0         0.0
         W             13          0.0         0.002460    0.007740    0.004140    0.0         0.0
         WNW           14          0.0         0.002220    0.009420    0.006660    0.001080    0.0
         NW            15          0.0         0.001380    0.014640    0.009660    0.001680    0.0
         NNW           16          0.0         0.001680    0.018000    0.019620    0.001380    0.0
```

Figure C.3. TEST CITY Printed Output, continued.

```
                         C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                AQDM TEST CITY
                                                  RUN   100

                                     METEOROLOGICAL JOINT FREQUENCY FUNCTION

STABILITY CLASS 5                                               W I N D   S P E E D   C L A S S

    WIND DIRECTION    SECTOR              1           2           3           4           5           6

          N              1              0.0       0.000720    0.021040    0.015320    0.001480    0.0
          NNE            2              0.0       0.000360    0.005360    0.006280    0.001120    0.0
          NE             3              0.0       0.000360    0.004240    0.005920    0.000200    0.0
          ENE            4              0.0       0.001480    0.004240    0.004240    0.000200    0.0
          E              5              0.0       0.002240    0.005920    0.005520    0.002200    0.000560
          ESE            6              0.0       0.001120    0.004040    0.020280    0.004440    0.000560
          SE             7              0.0       0.000560    0.008680    0.016400    0.002040    0.000200
          SSE            8              0.0       0.000720    0.007000    0.009760    0.001120    0.0
          S              9              0.0       0.000200    0.005920    0.012000    0.000920    0.0
          SSW           10              0.0       0.000560    0.003520    0.003520    0.0         0.0
          SW            11              0.0       0.000720    0.000720    0.0         0.0         0.0
          WSW           12              0.0       0.000360    0.003520    0.000200    0.0         0.0
          W             13              0.0       0.001640    0.005160    0.002760    0.0         0.0
          WNW           14              0.0       0.001480    0.006280    0.004440    0.000720    0.0
          NW            15              0.0       0.000920    0.009760    0.006440    0.001120    0.0
          NNW           16              0.0       0.001120    0.012000    0.013080    0.000920    0.0

STABILITY CLASS 6                                               W I N D   S P E E D   C L A S S

    WIND DIRECTION    SECTOR              1           2           3           4           5           6

          N              1            0.005100    0.012400    0.021200    0.0         0.0         0.0
          NNE            2            0.000500    0.002800    0.004600    0.0         0.0         0.0
          NE             3            0.000900    0.005100    0.002800    0.0         0.0         0.0
          ENE            4            0.003200    0.007800    0.004100    0.0         0.0         0.0
          E              5            0.010600    0.016100    0.005500    0.0         0.0         0.0
          ESE            6            0.005500    0.016100    0.012400    0.0         0.0         0.0
          SE             7            0.001400    0.006900    0.004600    0.0         0.0         0.0
          SSE            8            0.000900    0.005100    0.005100    0.0         0.0         0.0
          S              9            0.002800    0.004600    0.002300    0.0         0.0         0.0
          SSW           10            0.005100    0.006500    0.0         0.0         0.0         0.0
          SW            11            0.000900    0.003700    0.0         0.0         0.0         0.0
          WSW           12            0.001800    0.003700    0.0         0.0         0.0         0.0
          W             13            0.001800    0.006500    0.000500    0.0         0.0         0.0
          WNW           14            0.005500    0.012000    0.003700    0.0         0.0         0.0
          NW            15            0.008800    0.011100    0.003700    0.0         0.0         0.0
          NNW           16            0.003200    0.011500    0.006900    0.0         0.0         0.0
```

Figure C.3. TEST CITY Printed Output, continued.

```
                        C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                AQDM TEST CITY
                                                  RUN   100

                                        AREA AND POINT SOURCE INVENTORY

                                        EMISSION RATE  EMISSION RATE                          STACK          STACK        OPTIONAL
   POINT        X MAP        Y MAP         FOR SO2        FOR PART       STACK      STACK     EXIT            GAS        PLUME RISE
 SOURCE ID   COORDINATE   COORDINATE    (GRAMS/SEC)    (GRAMS/SEC)     HEIGHT      DIAM      SPEED           TEMP       COEFFICIENT
                                                                       (METERS)   (METERS)  (METERS/SEC)   (DEG CELS) (SQ METERS/SEC)
    1P        568.50       4403.40        1365.00         527.63       150.00      0.0        0.0            0.0           0.00 *
    2P        584.20       4391.60        1580.36         789.60        90.00      8.70      15.20         149.00          0.0
    3P        577.00       4401.10         221.76          34.13        30.00      0.70      17.80         515.00          0.0
    4P        574.10       4401.50         110.25          54.08        23.00      1.40      15.20         260.00          0.0

                 X MAP         Y MAP        WIDTH OF
   AREA       COORD OF SW   COORD OF SW   GRID SQUARE    EMISSION RATE   EMISSION RATE   EMISSION
 SOURCE ID    GRID CORNER   GRID CORNER    (METERS)         FOR SO2        FOR PART        HEIGHT
                                                         (GRAMS/SEC)     (GRAMS/SEC)     (METERS)
    1A          562.50        4402.50       5000.00          1.37            1.68          0.0
    2A          567.50        4402.50       5000.00          1.26            1.79          0.0
    3A          572.50        4402.50       5000.00          5.25            3.99         10.00
    4A          577.50        4402.50       5000.00          1.47           13.13          0.0
    5A          582.50        4402.50       5000.00          1.20            1.58          0.0
    6A          562.50        4397.50       5000.00          2.62            1.47         10.00
    7A          567.50        4392.50      10000.00         32.66           21.11         15.00
    8A          577.50        4397.50       5000.00          5.46            3.99         10.00
    9A          582.50        4397.50       5000.00          6.62            5.79         10.00
   10A          562.50        4392.50       5000.00          2.63            1.16         10.00
   11A          577.50        4392.50       5000.00          7.88            5.15         20.00
   12A          582.50        4392.50       5000.00          5.25            3.69         10.00
   13A          562.50        4387.50       5000.00          2.73            1.37          0.0
   14A          567.50        4387.50       5000.00          2.42            1.89         10.00
   15A          572.50        4387.50       5000.00          5.36            4.10         10.00
   16A          577.50        4387.50       5000.00          5.57            3.89         10.00
   17A          582.50        4387.50       5000.00          2.84            1.47         10.00
```

*Actual input is 0.0001.

Figure C.3. TEST CITY Printed Output, continued.

```
                    C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                          AQDM TEST CITY
                                          RUN    100

  ************************************  CALIBRATION PROCEDURE RESULTS: SO2   ************************************
REGRESSION COEFFICIENTS:  OBSERVED (MEASURED MINUS BACKGROUND) VERSUS CALCULATED CONCENTRATIONS

   PARAMETER                VALUE                         STANDARD DEVIATION

     SLOPE                   1.15                              0.15
     INTERCEPT              -4.12 MICROGRAMS/CU. METER         3.36 MICROGRAMS/CU. METER
     BACKGROUND              1.00 MICROGRAMS/CU. METER

ANALYSIS OF VARIANCE ANC 5% CONFIDENCE LEVEL TEST FOR CORRELATION COEFFICIENT

                            DEGREES OF      SUM OF        MEAN                           CORRELATION COEFFICIENT
   SCURCE                    FREEDOM        SQUARES       SQUARES      R - SQUARED      CALCULATED   5% CONF. LEVEL

     REGRESSION                1            1034.28       1034.28         0.92             0.96          0.75

     LEVIATIONS
     ABOUT REGRESSION          5              85.72         17.14

     TCTAL                     6            1120.00

   AVERAGED OBSERVED CONCENTRATION:        19.00 MICROGRAMS/CU. METER
   AVERAGED CALCULATED CONCENTRATION:      20.10 MICROGRAMS/CU. METER

  ************************************  CALIBRATION PROCEDURE RESULTS: PART  ************************************
REGRESSICN COEFFICIENTS:  CBSERVED (MEASURED MINUS BACKGROUND) VERSUS CALCULATED CONCENTRATICNS

   PARAMETER                VALUE                         STANDAPD DEVIATION

     SLOPE                   1.46                              0.33
     INTERCEPT              -3.50 MICROGRAMS/CU. METER         3.15 MICROGRAMS/CU. METER
     BACKGROUND              1.00 MICROGRAMS/CU. METER

ANALYSIS OF VARIANCE AND 5% CONFIDENCE LEVEL TEST FOR CORRELATION COEFFICIENT

                            DEGREES OF      SUM OF        MEAN                           CORRELATION COEFFICIENT
   SCURCE                    FREEDOM        SQUARES       SQUARES      R - SQUARED      CALCULATED   5% CONF. LEVEL

     PEGRESSION                1             221.70        221.70         0.77             0.88          0.71

     DEVIATIONS
     ABOUT REGRESSION          6              66.18         11.03

     TOTAL                     7             287.88

   AVERAGED OBSERVED CONCENTRATION:         9.63 MICROGRAMS/CU. METER
   AVERAGED CALCULATED CONCENTRATION:       9.01 MICROGRAMS/CU. METER
```

Figure C.3. TEST CITY Printed Output, continued.

```
                    C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                          AQDM TEST CITY
                                          RUN   100

*******************************************************************************************
CALCULATED CORRELATION COEFFICIENTS GREATER THAN OR EQUAL TO THEORETICAL (5% CONF. LEVEL) VALUES:
COMPUTED REGRESSION CONSTANTS WILL BE USED TO CALIBRATE CALCULATED CONCENTRATIONS.
*******************************************************************************************

                       RECEPTOR DATA ASSOCIATED WITH REGRESSION PARAMETERS: SO2

                      LOCATION                              CONCENTRATION (MICROGRAMS/CU. METER)

RECEPTOR ID      X COORD       Y COORD          CALCULATED **                            CALCULATED **
                                                UNCALIBRATED          OBSERVED *         CALIBRATED

   TC01          562.00       4395.70               8.86                 9.00               6.07
   TC02          566.10       4400.00              16.67                17.00              15.06
   TC03          570.00       4393.20              20.25                11.00              19.17
   TC04          573.90       4388.90              14.07                13.00              12.06
   TC06          572.40       4402.20              44.35                49.00              46.90
   TC07          579.00       4394.00              20.67                19.00              19.66
   TC08          583.00       4399.20              15.81                15.00              14.07

                       RECEPTOR DATA ASSOCIATED WITH REGRESSION PARAMETERS: PART

                      LOCATION                              CONCENTRATION (MICROGRAMS/CU. METER)

RECEPTOR ID      X COORD       Y COORD          CALCULATED **                            CALCULATED **
                                                UNCALIBRATED          OBSERVED *         CALIBRATED

   TC01          562.00       4395.70               4.03                 5.00               2.38
   TC02          566.10       4400.00               7.28                 9.00               7.11
   TC03          570.00       4393.20               9.29                 7.00              10.03
   TC04          573.90       4388.90               6.97                10.00               6.66
   TC05          572.50       4396.70              10.61                 8.00              11.95
   TC06          572.40       4402.20              17.29                25.00              21.69
   TC07          579.00       4394.00               8.70                 7.00               9.17
   TC08          583.00       4399.20               7.90                 6.00               8.01

*   OBSERVED = INPUT MEASURED VALUE - INPUT BACKGROUND VALUE
**  BACKGROUND CONCENTRATION IS NOT INCLUDED
```

Figure C.3. TEST CITY Printed Output, continued.

```
                         C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L
                                                 AQDM TEST CITY
                                                   RUN   100
RESULTS: RECEPTOR NUMBER     1 (TC01)

         X COORDINATE:     562.00
         Y COORDINATE:    4395.70

         ************************************* POINT ROSES (MICROGRAMS/CU. METPR) *************************************

         CARD ID        N     NNE   NE    ENE   E     ESE   SE    SSE   S     SSW   SW    WSW   W     WNW   NW    NNW
         P1 (SO2 )      0.0   0.0   2.0   1.6   0.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         P2 (PART)      0.0   0.0   0.7   0.3   0.3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0

         ************************************* AREA ROSES (MICROGRAMS/CU. METER) *************************************

         CARD ID        N     NNE   NE    ENE   E     ESE   SE    SSE   S     SSW   SW    WSW   W     WNW   NW    NNW
         A1 (SO2 )      0.0   0.0   0.1   0.3   0.7   0.4   0.1   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
         A2 (PART)      0.0   0.0   0.1   0.2   0.4   0.2   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

Figure 3.3. TEST CITY Printed Output, continued.

```
                         C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                  AQDM TEST CITY
                                                    RUN   100

RESULTS: RECEPTOR NUMBER     2 (TC02)

        X COORDINATE:      566.10
        Y COORDINATE:     4400.00

        ************************************ POINT ROSES (MICROGRAMS/CU. METER) ************************************

        CARD ID       N     NNE   NE    ENE   E     ESE   SE    SSE   S     SSW   SW    WSW   W     WNW   NW    NNW
        P1 (SO2 )     0.0   0.0   3.5   0.0   5.9   1.9   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
        P2 (PART)     0.0   0.0   1.5   0.0   1.6   1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0

        ************************************ AREA ROSES (MICROGRAMS/CU. METER) ************************************

        CARD ID       N     NNE   NE    ENE   E     ESE   SE    SSE   S     SSW   SW    WSW   W     WNW   NW    NNW
        A1 (SO2 )     0.2   0.1   0.1   0.3   0.9   0.9   0.4   0.2   0.1   0.1   0.0   0.0   0.0   0.1   0.1   0.1
        A2 (PART)     0.2   0.1   0.1   0.5   0.7   0.6   0.3   0.1   0.1   0.1   0.0   0.0   0.0   0.0   0.1   0.1
```

Figure C.3. TEST CITY Printed Output, continued.

```
                        C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                              AQDM TEST CITY
                                                RUN   100

RESULTS: RECEPTOR NUMBER     5 (TC05)

         X COORDINATE:      572.50
         Y COORDINATE:     4396.70

     ************************************* POINT ROSES (MICROGRAMS/CU. METER) *************************************

     CARD ID          N     NNE    NE    ENE    E     ESE    SE    SSE    S     SSW    SW    WSW    W     WNW    NW    NNW
     E1 (SO2 )       0.0    2.1   3.9    0.0   0.0    2.2   0.0    0.0   0.0    0.0   0.0    0.0   0.0    0.0   0.0    8.9
     E2 (PART)       0.0    1.2   0.7    0.0   0.0    1.2   0.0    0.0   0.0    0.0   0.0    0.0   0.0    0.0   0.0    4.0

     ************************************** AREA ROSES (MICROGRAMS/CU. METER) *************************************

     CARD ID          N     NNE    NE    ENE    E     ESE    SE    SSE    S     SSW    SW    WSW    W     WNW    NW    NNW
     A1 (SO2 )       0.7    0.2   0.2    0.4   0.8    0.8   0.4    0.3   0.2    0.2   0.1    0.1   0.2    0.3   0.5    0.4
     A2 (PART)       0.6    0.2   0.4    0.3   0.6    0.6   0.3    0.2   0.2    0.2   0.1    0.1   0.1    0.3   0.4    0.4

     ************************************** INDIVIDUAL SOURCE CONTRIBUTIONS **************************************

                                          POLLUTANT: PART

                                    MICROGRAMS/      PERCENTAGE
                                    CU. METER         OF TOTAL

        POINT SOURCES

              1P                       3.97            30.62
              2P                       1.25             9.62
              3P                       0.69             5.35
              4P                       1.19             9.18

        AREA SOURCES

              1A                       0.11             0.83
              2A                       0.14             1.09
              3A                       0.15             1.17
              4A                       0.28             2.13
              5A                       0.03             0.23
              6A                       0.06             0.48
              7A                       2.98            22.99
              8A                       0.12             0.96
              9A                       0.16             1.21
             10A                       0.02             0.17
             11A                       0.30             2.32
             12A                       0.14             1.09
             13A                       0.02             0.15
             14A                       0.05             0.42
             15A                       0.13             1.00
```

Figure C.3. TEST CITY Printed Output, continued.

```
                         C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                  AQDM TEST CITY
                                                    RUN   100
RESULTS: RECEPTOR NUMBER    5 (TC05)

        ************************************** INDIVIDUAL SOURCE CONTRIBUTIONS **************************************

                                                  POLLUTANT: PART

                                          MICROGRAMS/          PERCENTAGE
                                           CU. METER            OF TOTAL

           AREA SOURCES

              16A                              0.11               0.87
              17A                              0.04               0.34

           SOURCES INDIVIDUALLY CON-
           TRIBUTING LESS THAN  0.0 %          0.0                0.0

           BACKGROUND                          1.00               0.0

           TOTAL                              12.95             100.00
```

Figure C.3. TEST CITY Printed Output, continued.

```
                       C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                AQDM TEST CITY
                                                 RUN   100
RESULTS: RECEPTOR NUMBER    8 (TC08)

         X COORDINATE:     583.00
         Y COORDINATE:    4399.20

           ************************************ INDIVIDUAL SOURCE CONTRIBUTIONS ************************************

                                         POLLUTANT: SO2                        POLLUTANT: PART

                                   MICROGRAMS/      PERCENTAGE           MICROGRAMS/      PERCENTAGE
                                   CU. METER        OF TOTAL             CU. METER        OF TOTAL
             POINT SOURCES

                  1P                  2.41            16.01                 1.06            11.79
                  2P                  0.60             4.00                 0.34             3.81
                  3P                  6.08            40.31                 1.07            11.83
                  4P                  0.96             6.36                 0.54             5.95

             AREA SOURCES

                  1A                  0.03             0.22                 0.05             0.51
                  2A                  0.03             0.22                 0.05             0.59
                  3A                  0.16             1.09                 0.14             1.58
                  4A                  0.14             0.93                 1.43            15.88
                  5A                  0.09             0.62                 0.14             1.56
                  6A                  0.02             0.12                 0.01             0.13
                  7A                  0.37             2.45                 0.27             3.01
                  8A                  0.58             3.82                 0.48             5.32
                  9A                  1.93            12.81                 1.92            21.31
                 10A                  0.01             0.10                 0.01             0.08
                 11A                  0.17             1.14                 0.13             1.43
                 12A                  0.28             1.84                 0.22             2.46
                 13A                  0.01             0.09                 0.01             0.09
                 14A                  0.01             0.06                 0.01             0.11
                 15A                  0.03             0.21                 0.03             0.31
                 16A                  0.09             0.61                 0.07             0.81
                 17A                  0.05             0.32                 0.03             0.31

             SOURCES INDIVIDUALLY CON-
             TRIBUTING LESS THAN  0.0 %       0.0              0.0                  0.0              0.0

             BACKGROUND                       1.00             0.0                  1.00            11.10

             TOTAL                           15.07           100.00                 9.01           100.00
```

Figure C.3. TEST CITY Printed Output, continued.

```
                    C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                           AQDM TEST CITY
                                            RUN    100

RESULTS: RECEPTOR NUMBER    9 (TC09)

        X COORDINATE:     577.50
        Y COORDINATE:    4397.50

   ************************************  POINT ROSES (MICROGRAMS/CU. METER)  ************************************

   CARD ID        N     NNE    NE    ENE    E     ESE    SE    SSE    S     SSW    SW    WSW    W     WNW    NW    NNW
   P1 (SO2 )    27.3   0.0   0.0   0.0   0.0   0.0   1.6   0.0   0.0   0.0   0.0   0.0   0.0   4.1   2.9   0.0
   P2 (PART)     4.7   0.0   0.0   0.0   0.0   0.0   0.9   0.0   0.0   0.0   0.0   0.0   0.0   1.8   1.6   0.0

   ************************************  AREA ROSES (MICROGRAMS/CU. METER)  ************************************

   CARD ID        N     NNE    NE    ENE    E     ESE    SE    SSE    S     SSW    SW    WSW    W     WNW    NW    NNW
   A1 (SO2 )     0.6   0.1   0.2   0.3   0.6   0.6   0.4   0.3   0.3   0.3   0.1   0.2   0.3   0.5   0.6   0.5
   A2 (PART)     0.8   0.3   0.2   0.3   0.5   0.4   0.3   0.2   0.2   0.2   0.1   0.1   0.2   0.4   0.5   0.4
```

Figure C.3. TEST CITY Printed Output, continued.

```
                              C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                     AQDM TEST CITY
                                                        RUN   100

RESULTS: RECEPTOR NUMBER   10 (TC10)

        X COORDINATE:       576.00
        Y COORDINATE:      4403.00

        *************************************  POINT ROSES (MICROGRAMS/CU. METER)  *************************************

        CARD ID        N     NNE    NE    ENE    E     ESE    SE    SSE    S      SSW    SW    WSW    W     WNW    NW    NNW
        F1 (SO2 )      0.0   0.0   0.0    0.0   0.0    0.0   1.8   21.4   0.0    0.0   0.8    0.0   4.4    0.0   0.0   0.0
        F2 (PART)      0.0   0.0   0.0    0.0   0.0    0.0   1.0    3.7   0.0    0.0   0.4    0.0   1.9    0.0   0.0   0.0

        *************************************  AREA ROSES (MICROGRAMS/CU. METER)  *************************************

        CARD ID        N     NNE    NE    ENE    E     ESE    SE    SSE    S      SSW    SW    WSW    W     WNW    NW    NNW
        A1 (SO2 )      0.3   0.1   0.1    0.2   0.4    0.7   0.4    0.4   0.4    0.4   0.1    0.2   0.2    0.3   0.3   0.2
        A2 (PART)      0.3   0.1   0.3    0.7   1.2    0.6   0.3    0.3   0.3    0.3   0.1    0.1   0.2    0.3   0.2   0.2

        *************************************  INDIVIDUAL SOURCE CONTRIBUTIONS  *************************************

                                                  POLLUTANT: SO2

                                          MICROGRAMS/        PERCENTAGE
                                           CU. METER          OF TOTAL

              POINT SOURCES

                  1P                           4.38             12.90
                  2P                           1.83              5.40
                  3P                          21.43             63.15
                  4P                           0.76              2.25

              AREA SOURCES

                  1A                           0.05              0.14
                  2A                           0.10              0.29
                  3A                           1.76              5.20
                  4A                           0.18              0.54
                  5A                           0.07              0.20
                  6A                           0.03              0.08
                  7A                           1.05              3.08
                  8A                           0.46              1.35
                  9A                           0.34              1.00
                 10A                           0.01              0.04
                 11A                           0.15              0.44
                 12A                           0.11              0.31
                 13A                           0.02              0.06
                 14A                           0.03              0.09
                 15A                           0.07              0.21
```

Figure C.3. TEST CITY Printed Output, continued.

```
                                   C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                         AQDM TEST CITY
                                                           RUN   100
RESULTS: RECEPTOR NUMBER   10 (TC10)

          **************************************  INDIVIDUAL SOURCE CONTRIBUTIONS  **************************************

                                                  POLLUTANT: SO2

                                           MICROGRAMS/        PERCENTAGE
                                            CU. METER          OF TOTAL

               AREA SOURCES

                    16A                          0.07               0.20
                    17A                          0.03               0.10

               SOURCES INDIVIDUALLY CON-
               TRIBUTING LESS THAN  0.0 %        0.0                0.0

               BACKGROUND                        1.00               0.0

               TOTAL                            33.94             100.00
```

Figure C.3. TEST CITY Printed Output, continued.

```
                    C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                           AQDM TEST CITY
                                           RUN   100


                              CALIBRATED CONCENTRATION (MICROGRAMS/CU. METER)

                                    POLLUTANT: SO2                                          POLLUTANT: PART

RECEPTOR       X           Y              POINT       AREA                                POINT       AREA
NC.   ID     COORD       COORD           SOURCES     SOURCES   BACKGROUND     TOTAL       SOURCES     SOURCES   BACKGROUND     TOTAL

  1 TC01     562.00     4395.70            4.3         1.8        1.0          7.1          1.3         1.1        1.0          3.4
  2 TC02     566.10     4400.00           11.3         3.8        1.0         16.1          4.0         3.1        1.0          8.1
  3 TC03     570.00     4393.20           14.0         5.1        1.0         20.2          5.9         4.1        1.0         11.0
  4 TC04     573.90     4388.90            8.2         3.9        1.0         13.1          3.4         3.2        1.0          7.7
  5 TC05     572.50     4396.70           17.0         5.8        1.0         23.9          7.1         4.9        1.0         13.0
  6 TC06     572.40     4402.20           41.7         5.2        1.0         47.9         16.3         5.4        1.0         22.7
  7 TC07     579.00     4394.00           14.6         5.1        1.0         20.7          4.6         4.5        1.0         10.2
  8 TC08     583.00     4399.20           10.1         4.0        1.0         15.1          3.0         5.0        1.0          9.0
  9 TC09     577.50     4397.50           35.8         5.8        1.0         42.6          8.9         5.1        1.0         15.0
 10 TC10     576.00     4403.00           28.4         4.5        1.0         33.9          7.0         5.5        1.0         13.5
```

Figure C.3. TEST CITY Printed Output, continued.

```
                         C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                 AQDM TEST CITY
                                                  RUN   100

                         STATISTICAL DATA AT SELECTED RECEPTORS (MICROGRAMS/CU. METER)
AVERAGING TIME =  1.0 HOURS

                                                 POLLUTANT: SO2
                                                                                                                 EXPECTED
                                                             EXPECTED            EXPECTED           STANDARD       ANNUAL
RECEPTOR    RECEPTOR                                         GEOMETRIC           MAXIMUM           GEOMETRIC     ARITHMETIC
 NUMBER        ID        X COORD     Y COORD                   MEAN           CONCENTRATION         DEVIATION       MEAN

    1         TC01        562.00     4395.70                   2.30               38.03               2.09            7.07
    3         TC03        570.00     4393.20                   6.28              109.60               2.12           20.17
```

Figure C.3. TEST CITY Printed Output, continued.

```
                    C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                          AQDM TEST CITY
                                           RUN    100

                    STATISTICAL DATA AT SELECTED RECEPTORS (MICROGRAMS/CU. METER)

AVERAGING TIME =  8.0 HOURS
                                          POLLUTANT: SO2
                                                                                                   EXPECTED
                                                   EXPECTED          EXPECTED          STANDARD      ANNUAL
RECEPTOR   RECEPTOR                                GEOMETRIC         MAXIMUM           GEOMETRIC   ARITHMETIC
 NUMBER       ID       X COORD     Y COORD           MEAN         CONCENTRATION        DEVIATION      MEAN

    1        TC01       562.00     4395.70             4.27              35.23             1.91        7.07
    3        TC03       570.00     4393.20            11.96             102.57             1.93       20.17
```

Figure C.3. TEST CITY Printed Output, continued.

```
                          C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                AQDM TEST CITY
                                                 RUN   100

                          STATISTICAL DATA AT SELECTED RECEPTORS (MICROGRAMS/CU. METER)
AVERAGING TIME = 24.0 HOURS

                                                POLLUTANT: SO2

                                                                                                    EXPECTED
RECEPTOR    RECEPTOR                            EXPECTED          EXPECTED           STANDARD        ANNUAL
 NUMBER        ID       X COORD    Y COORD      GEOMETRIC          MAXIMUM           GEOMETRIC     ARITHMETIC
                                                  MEAN          CONCENTRATION        DEVIATION        MEAN

    1         TC01       562.00    4395.70          5.93              33.92              1.81            7.07
    3         TC03       570.00    4393.20         16.81              99.31              1.83           20.17
```

Figure C.3. TEST CITY Printed Output, continued.

```
                           C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                  AQDM TEST CITY
                                                    RUN   100

                           STATISTICAL DATA AT SELECTED RECEPTORS (MICROGRAMS/CU. METER)

AVERAGING TIME =  4.0 HOURS
                                                 POLLUTANT: PART
                                                                                                         EXPECTED
                                                   EXPECTED           EXPECTED           STANDARD          ANNUAL
RECEPTOR    RECEPTOR                               GEOMETRIC          MAXIMUM            GEOMETRIC       ARITHMETIC
 NUMBER        ID        X COORD     Y COORD        MEAN           CONCENTRATION         DEVIATION          MEAN

    1         TC01        562.00     4395.70         1.91              15.52               1.83             3.38
    4         TC04        573.90     4388.90         4.62              33.31               1.77             7.66
    5         TC05        572.50     4396.70         7.15              60.82               1.86            12.95
```

Figure C.3. TEST CITY Printed Output, continued.

```
                    C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                              AQDM TEST CITY
                                                RUN   100

                          STATISTICAL DATA AT SELECTED RECEPTORS (MICROGRAMS/CU. METER)
AVERAGING TIME =  8.0 HOURS
                                              POLLUTANT: PART
                                                                                                      EXPECTED
                                                    EXPECTED           EXPECTED          STANDARD      ANNUAL
RECEPTOR   RECEPTOR                                 GEOMETRIC          MAXIMUM           GEOMETRIC   ARITHMETIC
 NUMBER       ID      X COORD    Y COORD              MEAN          CONCENTRATION        DEVIATION      MEAN

    1        TC01      562.00    4395.70              2.26              14.89               1.78         3.38
    4        TC04      573.90    4388.90              5.35              31.74               1.73         7.66
    5        TC05      572.50    4396.70              8.50              58.50               1.81        12.95
```

Figure C.3. TEST CITY Printed Output, continued.

```
                              C L I M A T O L O G I C A L   D I S P E R S I O N   M O D E L

                                                    AQDM TEST CITY
                                                    RUN    100

                              STATISTICAL DATA AT SELECTED RECEPTORS (MICROGRAMS/CU. METER)

AVERAGING TIME = 24.0 HOURS
                                                    POLLUTANT: PART
                                                                                                                    EXPECTED
                                                         EXPECTED           EXPECTED               STANDARD          ANNUAL
RECEPTOR   RECEPTOR                                      GEOMETRIC          MAXIMUM                GEOMETRIC       ARITHMETIC
 NUMBER       ID        X COORD     Y COORD                MEAN          CONCENTRATION             DEVIATION          MEAN

    1        TC01        562.00     4395.70                 2.93              13.95                   1.70            3.38
    4        TC04        573.90     4388.90                 6.76              29.44                   1.65            7.66
    5        TC05        572.50     4396.70                11.18              55.07                   1.72           12.95
```

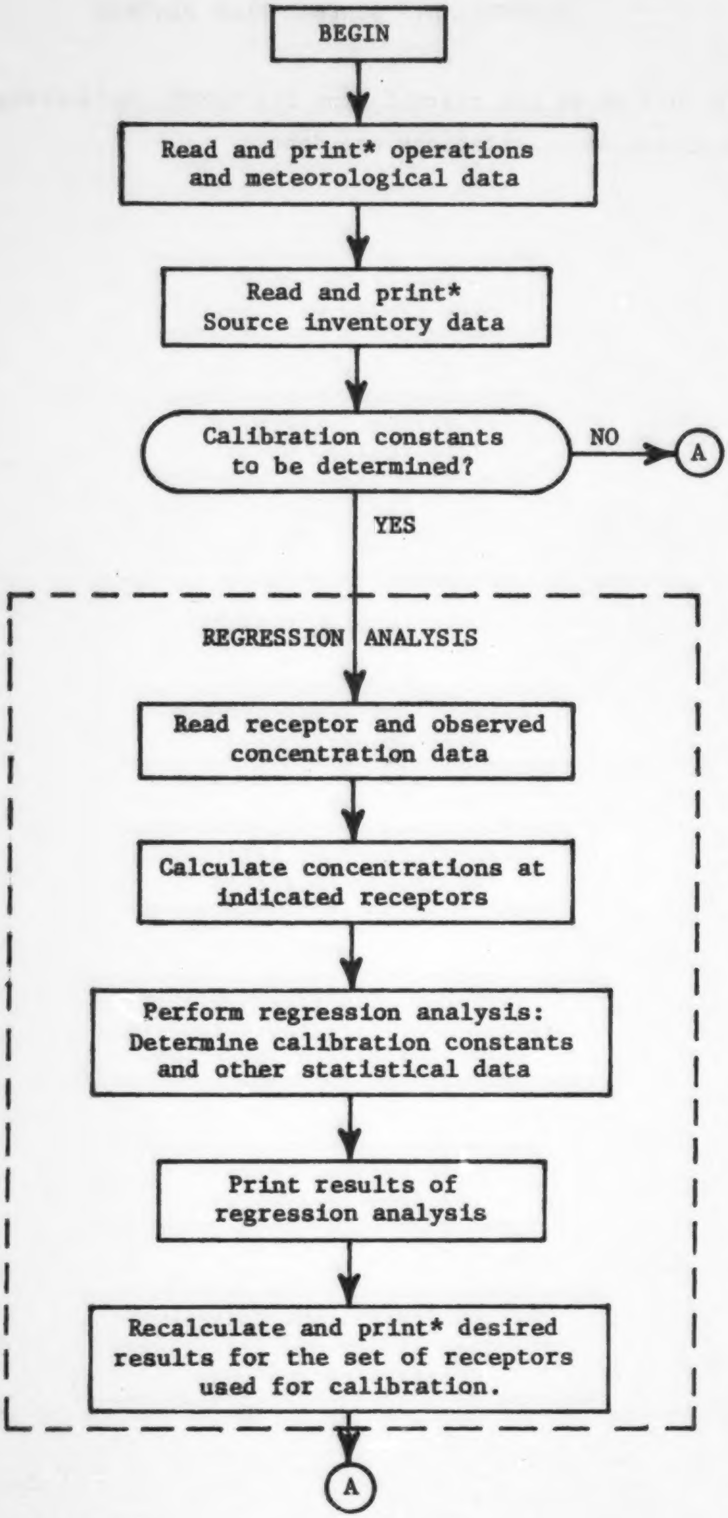
Figure C.3. TEST CITY Printed Output, continued.

```
P1    0     0    4    0    6    2    0    0    0    0    0    0    0    0    0   0 56609440000
P2    0     0    1    0    2    1    0    0    0    0    0    0    0    0    0   0 56609440000
A1    0     0    0    0    1    1    0    0    0    0    0    0    0    0    0   0 56609440000
A2    0     0    0    1    1    1    0    0    0    0    0    0    0    0    0   0 56609440000
  1.02  1.02    6    5   17    7    1    1   24   13   16    7       572.50   4396.70   100I
P1    0     2    4    0    0    2    0    0    0    0    0    0    0    0    0   9 57250439669
P2    0     1    1    0    0    1    0    0    0    0    0    0    0    0    0   4 57250439669
A1    1     0    0    0    1    1    0    0    0    0    0    0    0    0    0   0 57250439669
A2    1     0    0    0    1    1    0    0    0    0    0    0    0    0    0   0 57250439669
  1.02  1.03    5    5   42   16    1    1   48   23   16    7       572.40   4402.20   100I
  1.03  1.03    4    5   10    3    1    1   15    9   16    7       583.00   4399.20   100I
  1.03  1.02    6    5   36    9    1    1   43   15    0    0       577.50   4397.50   100I
P1   27     0    0    0    0    0    2    0    0    0    0    0    0    4    3   0 57750439750
P2    5     0    0    0    0    0    1    0    0    0    0    0    0    2    2   0 57750439750
A1    1     0    0    0    1    1    0    0    0    0    0    0    0    1    1   1 57750439750
A2    1     0    0    0    0    0    0    0    0    0    0    0    0    0    0   0 57750439750
  1.03  1.03    5    5   28    7    1    1   34   13    0    0       576.00   4403.00   100I
P1    0     0    0    0    0    0    2   21    0    0    1    0    4    0    0   0 57600440300
P2    0     0    0    0    0    0    1    4    0    0    0    0    2    0    0   0 57600440300
A1    0     0    0    0    0    1    0    0    0    0    0    0    0    0    0   0 57600440300
A2    0     0    0    1    1    1    0    0    0    0    0    0    0    0    0   0 57600440300
```

Figure C.4. TEST CITY Punched Output

APPENDIX D. GENERAL FLOW DIAGRAM

Fig. D.1 shows the overall flow for CDMQC, indicating in what order each general set of calculations are done.


BEGIN
Read and print* operations and meteorological data
Read and print* Source inventory data
Calibration constants to be determined?
NO
A
YES
REGRESSION ANALYSIS
Read receptor and observed concentration data
Calculate concentrations at indicated receptors
Perform regression analysis: Determine calibration constants and other statistical data
Print results of regression analysis
Recalculate and print* desired results for the set of receptors used for calibration.
A

*Asterisks denote output subject to user option.

Figure D.1. CDMQC Flow Diagram

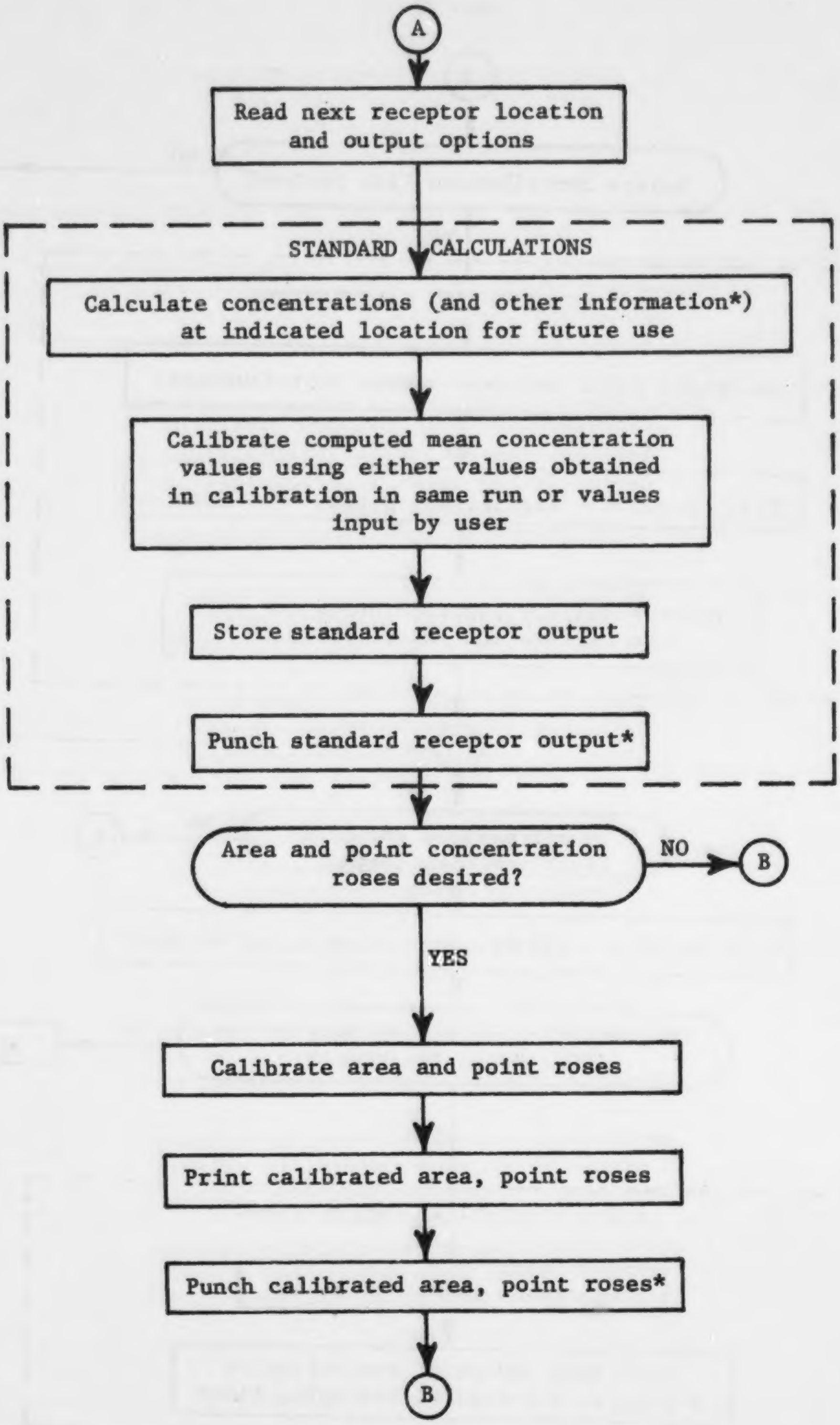

A
Read next receptor location and output options
STANDARD CALCULATIONS
Calculate concentrations (and other information*) at indicated location for future use
Calibrate computed mean concentration values using either values obtained in calibration in same run or values input by user
Store standard receptor output
Punch standard receptor output*
Area and point concentration roses desired?
NO
B
YES
Calibrate area and point roses
Print calibrated area, point roses
Punch calibrated area, point roses*
B

Figure D.1. CDMQC Flow Diagram, continued.

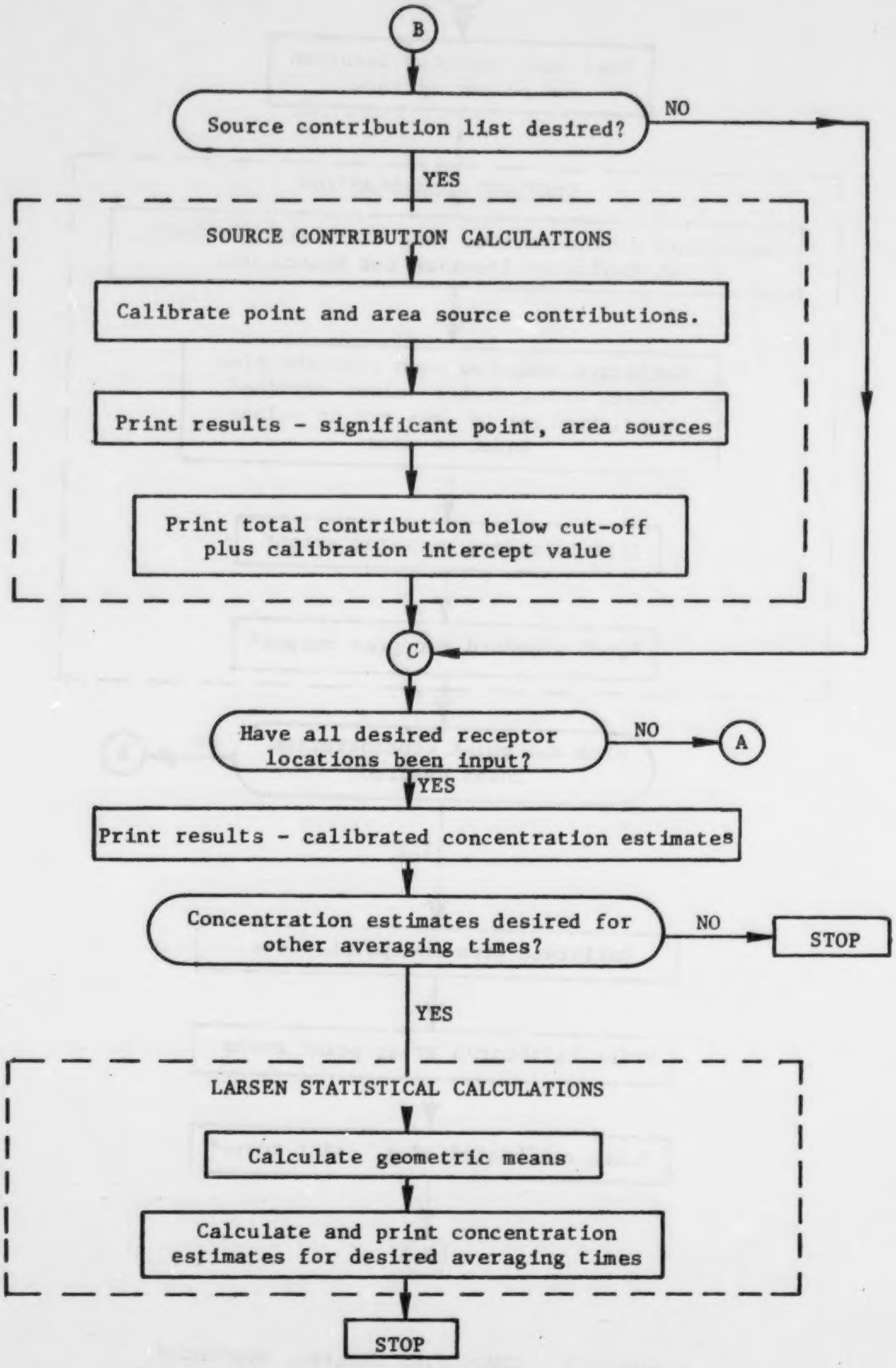

B
Source contribution list desired?
NO
YES
SOURCE CONTRIBUTION CALCULATIONS
Calibrate point and area source contributions.
Print results - significant point, area sources
Print total contribution below cut-off plus calibration intercept value
C
Have all desired receptor locations been input?
NO
A
YES
Print results - calibrated concentration estimates
Concentration estimates desired for other averaging times?
NO
STOP
YES
LARSEN STATISTICAL CALCULATIONS
Calculate geometric means
Calculate and print concentration estimates for desired averaging times
STOP

Figure D.1. CDMQC Flow Diagram, continued.

APPENDIX E. COMPUTER PROGRAM LISTINGS

Fig. E.1 gives the detailed FORTRAN listing of the entire CDMQC computer program, separated for convenience into parts corresponding to each separate routine in the program.

```
C       CDM CLIMATOLOGICAL DISPERSION MODEL       (BATCH)              CDM00010
      DIMENSION DX(4),DY(4),A(4),KPX(18),TCON(2)                        CDM00020
      DIMENSION PCBAR(2),PCFPC(2)                                       CDM00030
      COMMON /C1/ K,MX,MN,HT,F(6,6,16),G(6,5),U(6),RI,RJ,INC(4),DELR    CDM00040
      COMMON /C2/ UE(6),YD,YM,TMN,HMIN,DINT,YCON,TA(4),IPG,XG,YG,IRD    CDM00050
      COMMON /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG     CDM00060
      COMMON /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVER,IWR   CDM00070
      COMMON /C5/ Q(100,4),GA(2),IAD(4,5),XGG,YGG,IAS,IDA,IDB,IDC,IPU   CDM00080
      COMMON /C6/ NROSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,       CDM00090
     X            IHD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA        CDM00100
      COMMON /QCOM/ N,DR,IX,IY,TT(16,21),KTC,IXX,IYY,RAD,Z(50,50,3),TD  CDM00110
      COMMON /ACOM/ PI,SZA(6),ABAR(2),AROSE(16,2),XS(6)                 CDM00120
      COMMON /PCOM/ PH(200),PR(200),PS(200,4),PX(200),PY(200),PB(200),  CDM00130
     *XX(200),DHP(200),WA(16),WB(16),PROSE(16,2),CV,IFS,RAT,TOA,PBAR(2),CDM00140
     *PCINTS(200,2)                                                     CDM00150
      COMMON /DISPLA/ ZSOURC(2500,2)                                    CDM00160
      COMMON /REG/ IFLG,NCAIR,IOCAL,NCL,NCL1,NCL2,RXS(200),RYS(200),    CDM00170
     X             OBS(200,2),SGDS(200,2),IPNCHS(50),NROSES(50),        CDM00180
     X             NCULPS(50),NLARSS(200),NRAMS(200),CALC(200,2),       CDM00190
     X             KFLG,JFLG,COPS(2),NRAM,CORREL(100),BKGR(2),RX,RY,    CDM00200
     X             TOTC(200,2)                                          CDM00210
      COMMON/LARS/SGD(2),PAV(3,2),CCON(2),NLARS                         CDM00220
C                                                                       CDM00230
C        FORM OF INPUT TO CDM (BATCH)                                   CDM00240
C                                                                       CDM00250
C     VARIABLE                                                          CDM00260
C      NAME                                                             CDM00270
C          COLUMNS                                                      CDM00280
C               FORM    VARIABLE                                        CDM00290
C                                                                       CDM00300
C   CARD 1 * * * TITLE * * *                                            CDM00310
C                                                                       CDM00320
C     ITIT   1-80 20A4               USER-DEFINED RUN TITLE             CDM00330
C                                                                       CDM00340
C   CARD 2 * * * PARAMETERS * * *                                       CDM00350
C                                                                       CDM00360
C     AROS    1-8  2A4   AAAA       ALPHA AREA ROSE OUTPUT ID           CDM00370
C     PROS    9-16 2A4   AAAA       ALPHA POINT ROSE OUTPUT ID          CDM00380
C     IRUN   17-21  I5   XXXXX      USER DEFINED RUN ID NUMBER          CDM00390
C     NLIST1 23-24 I2    XX         SELECIS WIND ROSE INPUT LIST OPTION CDM00400
C     NLIST2 25-26 I2    XX         SELECTS SOURCE INPUT LIST OPTION    CDM00410
C     IRD    27-31  I5   XXXXX      FORTRAN LOGICAL UNIT NUMBER (READER) CDM00420
C     IWR    32-36  I5   XXXXX      FORTRAN LOGICAL UNIT NUMBER (PRINTER)CDM00430
C     IPU    37-41  I5   XXXXX      FORTRAN LOGICAL UNIT NUMBER (PUNCH) CDM00440
C     CA     42-59 2F9.0 XXXXXX.XX  INTERCEPT OF CALIBRATION            CDM00450
C     CB     60-77 2F9.0 XXXXXX.XX  SLOPE OF CALIBRATION                CDM00460
C                                                                       CDM00470
C                                                                       CDM00480
C   CARD 3 * * * PARAMETERS * * *                                       CDM00490
C                                                                       CDM00500
C     NCALR 1-6     I6   XXXXXX     NUMBER OF RECEPTORS FOR CALIBRATION CDM00510
C     IOCAL 8-11    I4   XXXX       SELECTS CALIBRATION OPTION          CDM00520
C     BKGR  13-32 2F10.  XXXXXXX.XX BACKGROUND CONCENTRATIONS FOR 2 P'S  CDM00530
C     LPNAM 13-21 2A4    AAAA AAAA  NAME OF 2 P'S                       CDM00540
C     PAV(1)44-55  F4.0 XX.X        AVERAGING TIMES FOR P1 FOR LARSEN   CDM00550
C     PAV(2)57-68  F4.0 XXX.X       AVERAGING TIMES FOR P2 FOR LARSEN   CDM00560
C     CTOF  70-74  F5.0 XX.XX       CUT-OFF PERC. FOR CULPABILITY LISTS CDM00570
```

Figure E.1. CDMQC FORTRAN Listing. Main Program

```
C                                                                       CDM00580
C  CARD 4 * * * PARAMTERS * * *                                         CDM00590
C                                                                       CDM00600
C     DELF    1-6   F6.0 XXXXX.     RADIAL INCREMENT (METERS)           CDM00610
C     RAT     7-12  F6.0 XXX.XX     EMISSION GRID-MAP GRID RATIO        CDM00620
C     CV     13-18  F6.0 XXXX.X     CONVERSION FACTOR                   CDM00630
C     HT     19-24  F6.0 XXXX.X     AVERAGE AFTERNOON MIXING HEIGHT (M) CDM00640
C     HMIN   25-30  F6.0 XXXX.X     AVERAGE NOCTURNAL MIXING HEIGHT (M) CDM00650
C     XG     31-36  F6.0 XXX.XX     X MAP COORD. (EMISSION)             CDM00660
C     YG     37-42  F6.0 XXX.XX     Y MAP COORD. (EMISSION)             CDM00670
C     XGG     43-48  F6.0 XXX.XX     X MAP COORD (OUTPUT)               CDM00680
C     YGG     49-54  F6.0 XXX.XX     Y MAP COORD (OUTPUT)               CDM00690
C     RATG   55-60  F6.0 XXX.XX     PLOT-GRID RATIO                     CDM00700
C     TCA    61-66  F6.0 XXX.XX     MEAN ATMOSPHERIC TEMP (DEG C)       CDM00710
C     TXX    67-72  F6.0 XXXXX.     SIDE LENGTH OF EMISSION CELL (METERS)CDM00720
C                                                                       CDM00730
C  CARD 5 * * * PARAMTERS * * *                                         CDM00740
C                                                                       CDM00750
C     DINT    1-6   F6.0 XXXXX.     SEGMENTS IN 22.5 DEGREE SECTOR      CDM00760
C     YD      7-12  F6.0 XXX.XX     DAYTIME-24HR EMISSION RATIO         CDM00770
C     YN     13-18  F6.0 XXX.XX     NIGHTTIME-24HR EMISSION RATIO       CDM00780
C     SZA    19-54 6F6.0 XXX.XX     INITIAL SIGMA Z (METERS)            CDM00790
C     GF     55-62 2F6.0 XXXXX.     DECAY HALF-LIFE (HOURS)             CDM00800
C                                                                       CDM00810
C  CARD 4-99 * * * JOINT FREQUENCY FUNCTION (FROM STAR - 36 CARDS) * * *CDM00820
C                                                                       CDM00830
C     F       8-49 6F7.0 .XXXXXX     F(I,J,K)      (PERCENT)            CDM00840
C                                                                       CDM00850
C  CARD 100-N * * * POINT SOURCE INVENTORY * * *                        CDM00860
C                                                                       CDM00870
C     X       1-6   F6.0 XXX.XX     X MAP COORD OF SOURCE (RE USER GUIDE)CDM00880
C     Y       7-13  F7.0 XXXX.XX    Y MAP COORD OF SOURCE (RE "USER GUIDE)CDM00890
C     S1     21-28  F8.0 XXXX.XXX   EMISSION OF POLLUTANT ONE (G/SEC)   CDM00900
C     S2     29-36  F8.0 XXXX.XXX   EMISSION OF POLLUTANT TWO (G/SEC)   CDM00910
C     SH     37-43  F7.0 XXX.XXX    STACK HEIGHT (METERS)               CDM00920
C     D      44-48  F5.0 XXX.X      STACK DIAMETER (METERS)             CDM00930
C     VS     49-55  F7.0 XXXX.XX    EXIT VELOCITY (M/SEC)               CDM00940
C     T      56-62  F7.0 XXXX.XX    STACK GAS TEMP (C)                  CDM00950
C     SR     63-67  F5.0 XXX.X      ZERO SELECTS BRIGGS PLUME RISE      CDM00960
C                                                                       CDM00970
C  CARD N+1 * * * BLANK SENTINEL CARD * * *                             CDM00980
C                                                                       CDM00990
C  CARD N+2-M * * * AREA SOURCE INVENTORY * * *                         CDM01000
C                                                                       CDM01010
C     X       1-6   F6.0 XXX.XX     X MAP COORD OF SOURCE (RE "USER GUIDE)CDM01020
C     Y       7-13  F7.0 XXXX.XX    Y MAP COORD OF SOURCE (RE "USER GUIDE)CDM01030
C     TX     14-20  F7.0 XXXX.XX    WIDTH OF AREA SOURCE                CDM01040
C     S1     21-28  F8.0 XXXX.XXX   EMISSION OF POLLUTANT ONE (G/SEC)   CDM01050
C     S2     29-36  F8.0 XXXX.XXX   EMISSION OF POLLUTANT TWO (G/SEC)   CDM01060
C     SH     37-43  F7.0 XXX.XXX    STACK HEIGHT (METERS)               CDM01070
C                                                                       CDM01080
C  CARD M+1 * * * BLANK SENTINEL CARD * * *                             CDM01090
C                                                                       CDM01100
C  CARD M+2-END * * * RECEPTOR CARDS * * *                              CDM01110
C                                                                       CDM01120
C     RX      1-8   F8.2 XXXX.XXX   X RECEPTOR COORD                    CDM01130
C     RY      9-16  F8.2 XXXX.XXX   Y RECEPTOR COORD                    CDM01140
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
C     COBS  30-41 2F6.0 XXXX.X      OBSERVED CONCENTRATIONS FOR 2 P'S     CDM01150
C     SGD   43-52 2F5.0 XXX.X       STANDARD GEOMETRIC DEVIATIONS         CDM01160
C     IPNCH 54-55       XX          0<IPNCH PUNCHES CONCENTRATION DATA    CDM01170
C     NROSE 56-57  I2   XX          SELECTS CONCENTRATION ROSE OUTPUT     CDM01180
C     NCULP 56-59  I2   XX          SELECTS SOURCE CONTRIBUTION OUTPUT    CDM01190
C     NLARS 60-61  I2   XX          SELECTS LARSEN OUTPUT OPTION          CDM01200
C     NRAM  77-80  A4   AAAA        RECEPTOR ID                           CDM01210
C                                                                         CDM01220
C         CLEAR AND INITIALIZE                                            CDM01230
      CALL CLINT                                                          CDM01240
C   IF ICHA = 1, ERROR HAS BEEN ENCOUNTERED ON AREA SOURCE INPUT          CDM01250
      IF (ICHA.EQ.1) GO TO 403                                            CDM01260
C                                                                         CDM01270
C        READ RECEPTOR COORDINATES                                        CDM01280
  401 READ(IRD,402,END=404) RX,RY,COBS,SGD,IPNCH,                         CDM01290
     X  NROSE,NCULP,NLARS,NRAM                                            CDM01300
  402 FORMAT(2F8.2,13X,2F6.0,1X,2F5.2,1X,4I2,15X,A4)                      CDM01310
C         RX: COORDINATE OF RECEPTOR                                      CDM01320
C         RY: COORDINATE OF RECEPTOR                                      CDM01330
C         COBS(1): OBSERVED P 1 CONCENTRATION AT THIS RECEPTOR IF KNOWN  CDM01340
C         COBS(2): OBSERVED  P 2 CONCENTRATION AT THIS RECEPTOR IF KNOWN CDM01350
C         SGD(N): STANDARD GEOMETRIC DEVIATION                            CDM01360
C                 N = 1 : P1 ; N = 2 : P2                                 CDM01370
C         IPNCH: PARAMETER INDICATING PUNCH OPTION DESIRED;               CDM01380
C                IF IPNCH>0, PUNCH STANDARD CONCENTRATION DATA            CDM01390
C         NROSE: CONTROL PARAMETER FOR CONCENTRATION ROSES PRINT, PUNCH  CDM01400
C         NCULP: CONTROL PARAMETER FOR CULPABILITY LIST PRINT             CDM01410
C         NLARS: CONTROL PARAMETER FOR LARSEN'S STATISTICAL PRINT OUTPUT CDM01420
C         NRAM: RECEPTOR IDENTIFICATION NAME                              CDM01430
C                                                                         CDM01440
C   JFLG INDICATES STATUS OF REGRESSION ANALYSIS                          CDM01450
C     JFLG = 0   NO ANALYSIS REQUESTED, OR REPROCESSING OF CALIBRATION    CDM01460
C                RECEPTORS IS COMPLETE                                    CDM01470
C     JFLG = 1   CALIBRATION RECEPTORS ARE BEING INPUT                    CDM01480
C     JFLG = 2   ANALYSIS IS COMPLETE; CALIBRATION RECEPTORS BEING        CDM01490
C                REPROCESSED                                              CDM01500
      IF (JFLG.EQ.0) GO TO 300                                            CDM01510
C   STORE CALIBRATION RECEPTOR INPUT DATA                                 CDM01520
      CALL SWITCH                                                         CDM01530
C   CALCULATE AND STORE CONCENTRATIONS FOR CALIBRATION RECEPTOR           CDM01540
      GO TO 852                                                           CDM01550
  298 CALL REGR                                                           CDM01560
      IF (JFLG.EQ.1) GO TO 403                                            CDM01570
      NCL = 0                                                             CDM01580
      KFLG = 2                                                            CDM01590
C   RETRIEVE CALIBRATION RECEPTOR INPUT DATA;                             CDM01600
C   DO STANDARD CALCULATIONS AND OUTPUT FOR RECEPTOR                      CDM01610
  299 CALL SWITCH                                                         CDM01620
  300 IF (NCULP.EQ.0) GO TO 853                                           CDM01630
C   FILL IPC ARRAY WITH POLLUTANTS FOR WHICH CULPABILITY DESIRED          CDM01640
      IF (NCULP.EQ.3) GO TO 847                                           CDM01650
      NPC = 1                                                             CDM01660
      IPC(1) = NCULP                                                      CDM01670
      GO TO 848                                                           CDM01680
  847 NPC = 2                                                             CDM01690
      IPC(1) = 1                                                          CDM01700
      IPC(2) = 2                                                          CDM01710
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
  848 DO 851 ICU=1,NPC
      IC = IPC(ICU)
C  INITIALIZE VATABLES FOR SOURCE CONTRIBUTION LIST(S)
      DO 849 IDUM=1,IAS
  849 ZSOURC(IDUM,IC) = 0.0
      DO 850 IPP=1,IPS
  850 PCINIS(IPP,IC) = 0.0
      PCREC(IC) = 0.0
      PCBAR(IC) = 0.0
  851 CONTINUE
C
C  INCREMENT NREC, RECEPTOR COUNT
  853 NREC = NREC + 1
      IF (NRCSE.EQ.0.AND.NCULP.EQ.0) GO TO 852
C  PRINT RECEPTOR HEADING
      WRITE(IWP,441) IHD,ITIT,TFUN,NREC,NRAM
  441 FORMAT('1',35X,16A4,//,26X,20A4,/,61X,'RUN ',I5,//,1X,
     X  'RESULTS: RECEPTOR NUMBER ',I4,' (',A4,')')
      WRITE(IWP,442) RX,RY
  442 FORMAT('0',9X,'X COORDINATE: ',F10.2,/,10X,
     X  'Y COORDINATE: ',F10.2)
      IPG = 9
C
C         CONVERT COORDINATES TO EMISSION GRID UNITS
  852 RI = (RX-XG)/FAT + 0.5
      RJ = (RY-YG)/FAT + 0.5
  499 K=1
C         K: PROGRESSES 1 THRU 16 CONTROLLING SECTOR (DIRECTION)
      DO500I=1,NPOL
      AEAR(I)=0.
      PEAR(I)=0.
      ARCSE(K,I)=0.
  500 PROSE(K,I)=0.
      IF(IAS.LT.1) GOTO666
C        DETERMINE MAX. DISTANCE FROM RECEPTOR ACROSS AREA GRID (MX)
      DX(1)=(IX-0.5)-RI
      DX(2)=(IXX+0.5)-RI
      DX(3)=DX(2)
      DX(4)=DX(1)
      DY(1)=(IY-0.5)-RJ
      DY(2)=DY(1)
      DY(3)=(IYY+0.5)-RJ
      DY(4)=DY(3)
      TX=(DX(1)*DX(1)+DY(1)*DY(1))**0.5
      TN=TX
      TM=(DX(2)*DX(2)+DY(1)*DY(1))**0.5
      IF(TM.GT.TX) TX=TM
      IF(TM.LT.TN) TN=TM
      TM=(DX(2)*DX(2)+DY(3)*DY(3))**0.5
      IF(TM.GT.TX) TX=TM
      IF(TM.LT.TN) TN=TM
      TM=(DX(1)*DX(1)+DY(3)*DY(3))**0.5
      IF(TM.GT.TX) TX=TM
      IF(TM.LT.TN) TN=TM
      MX=TX/DR
C       TEST IF RECEPTOR WITHIN AREA SOURCE
      IF(RI+0.5.LT.IX.OR.RI-0.5.GT.IXX) GOTO4
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
      IF(BJ+0.5.LT.IY.OR.BJ-0.5.GT.IYY) GOTO4                           CDM02290
      IE=1                                                              CDM02300
      NN=1                                                              CDM02310
      GOTO61                                                            CDM02320
    4 IE=2                                                              CDM02330
C       DETERMINE MINIMUM DISTANCE FROM RECEPTOR TO AREA SOURCES        CDM02340
      TMN=TN/DR                                                         CDM02350
      TXI=0.                                                            CDM02360
      TNI=400.                                                          CDM02370
      DO17I=1,4                                                         CDM02380
      IF(DX(I))5,6,7                                                    CDM02390
    5 IF(DY(I).EQ.0.) GOTO9                                             CDM02400
      TA(I)=ATAN(DY(I)/DX(I))*RAD+180.                                  CDM02410
      GOTO16                                                            CDM02420
    9 TA(I)=180.                                                        CDM02430
      GOTO16                                                            CDM02440
    6 IF(DY(I))10,11,12                                                 CDM02450
   10 TA(I)=270.                                                        CDM02460
      GOTO16                                                            CDM02470
   11 TA(I)=0.                                                          CDM02480
      GOTO16                                                            CDM02490
   12 TA(I)=90.                                                         CDM02500
      GOTO16                                                            CDM02510
    7 IF(DY(I))13,14,15                                                 CDM02520
   13 TA(I)=ATAN(DY(I)/DX(I))*RAD+360.                                  CDM02530
      GOTO16                                                            CDM02540
   14 TA(I)=360.                                                        CDM02550
      GOTO16                                                            CDM02560
   15 TA(I)=ATAN(DY(I)/DX(I))*RAD                                       CDM02570
   16 IF(TA(I).GT.TXI) TXI=TA(I)                                        CDM02580
      IF(TA(I).LT.TNI) TNI=TA(I)                                        CDM02590
   17 CONTINUE                                                          CDM02600
      TDIF=TXI-TNI                                                      CDM02610
   70 DO96I=1,4                                                         CDM02620
   96 A(I)=TA(I)                                                        CDM02630
      TX=TXI                                                            CDM02640
      TN=TNI                                                            CDM02650
      IF(TDIF.GT.180.) GOTO29 ← TM=90.-TK(K)                            CDM02660
      IF(TM.LT.0.) TM=TM+360.                                           CDM02670
   27 IF(TM.GE.TN-11.25) GOTO28                                         CDM02680
      IF(TM.GE.11.25) GOTO666                                           CDM02690
      TM=TM+360.                                                        CDM02700
   28 IF(TM-(TX+11.25))40,40,666                                        CDM02710
   29 TM=180.-TK(K)                                                     CDM02720
      IF(TM.LT.0.) TM=TM+360.                                           CDM02730
   30 TX=0.                                                             CDM02740
      TN=400.                                                           CDM02750
      DO36I=1,4                                                         CDM02760
      A(I)=A(I)+90.                                                     CDM02770
      IF(A(I).GE.360.) A(I)=A(I)-360.                                   CDM02780
      IF(A(I).GT.TX) TX=A(I)                                            CDM02790
      IF(A(I).LT.TN) TN=A(I)                                            CDM02800
   36 CONTINUE                                                          CDM02810
      IF(TX-TN.LE.180.) GOTO27                                          CDM02820
      TM=270.-TK(K)                                                     CDM02830
      IF(TM.LT.0.) TM=TM+360.                                           CDM02840
      GOTO30                                                            CDM02850
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
   40 DIF=(TX-TM)/(2.*PAD)                                                CDM02860
      MN=TMN*COS(DIF)                                                     CDM02870
C         NEGATE POSSIBLE ERROR IN COSINE FUNCTION.                       CDM02880
      L=MOD(MN,INC(4))                                                    CDM02890
      IF(L.LE.0) L=INC(4)                                                 CDM02900
      MN=MN-1                                                             CDM02910
C        MN ALWAYS EQUALS 1 IF RECEPTOR WITHIN AREA SOURCE GRID           CDM02920
      IF(MN.LT.1) MN=1                                                    CDM02930
   61 N=MN                                                                CDM02940
      CALL CALQ                                                           CDM02950
      CALL AREA                                                           CDM02960
      IF(NCULP.GT.0) CALL ARCAL                                           CDM02970
C        IF NO POINT SOURCES, GO TO NEXT SECTOR                           CDM02980
  666 IF(IPS.LE.0) GOTO408                                                CDM02990
      CALL PCINT                                                          CDM03000
  408 IF(K.GE.16) GOTO452                                                 CDM03010
      K=K+1                                                               CDM03020
C         K LOOPS THRU 16 SECTORS                                         CDM03030
      DO503I=1,NPOL                                                       CDM03040
      AROSE(K,I)=0.                                                       CDM03050
  503 PROSE(K,I)=0.                                                       CDM03060
C         IF NO AREA SOURCES, CHECK POINT SOURCES                         CDM03070
      IF(IAS.LT.1) GOTO666                                                CDM03080
C         BRANCH TO 61 OR 70 DEPENDS ON WHETHER RECEPTOR IS INSIDE AREA GCDM03090
      GOTO(61,70),IF                                                      CDM03100
  452 IF (JFLG.NE.1) GO TO 453                                            CDM03110
C  STORE RESULTS FOR CALIBRATION RECEPTOR                                 CDM03120
      DO451I=1,NPOL                                                       CDM03130
  451 CALC(NCL,I)=ABAR(I)+PBAR(I)                                         CDM03140
C  ARE ALL CALIBRATION RECEPTORS INPUT?                                   CDM03150
      IF (NCL.EQ.NCALR) JFLG = 2                                          CDM03160
      GO TO (401,298),JFLG                                                CDM03170
C                                                                         CDM03180
C  ACCUMULATE AND CALIBRATE                                               CDM03190
  453 DO505I=1,NPOL                                                       CDM03200
       TCON(I)=PBAR(I)+ABAR(I)                                            CDM03210
       IF (TCON(I).EQ.0.) GO TO 420                                       CDM03220
       PBAR(I) = CB(I)*PBAR(I) + CA(I)*PBAR(I)/TCON(I)                    CDM03230
       ABAR(I) = CB(I)*ABAR(I) + CA(I)*ABAR(I)/TCON(I)                    CDM03240
  420 CCON(I) = CA(I) + CB(I)*TCON(I) + BKGR(I)                           CDM03250
C  STORE RECEPTOR RESULTS AND INPUT FOR LATER CALCULATIONS, PRINTING.     CDM03260
C  NAMES (OBS AND CALC) BEAR NO RELATION TO MEANING OF THESE ARRAYS       CDM03270
C  AT THIS POINT IN CODE; ARRAYS ARE USED FOR SAVINGS ON STORAGE.         CDM03280
       OBS(NREC,I) = ABAR(I)                                              CDM03290
       CALC(NREC,I) = PBAR(I)                                             CDM03300
       TOTC(NREC,I) = CCON(I)                                             CDM03310
  505 SGDS(NREC,I) = SGD(I)                                               CDM03320
       RXS(NREC) = RX                                                     CDM03330
       RYS(NREC) = RY                                                     CDM03340
       NRAMS(NREC) = NRAM                                                 CDM03350
       NLARSS(NREC) = NLARS                                               CDM03360
C         ABAR: CALIBRATED CONTRIBUTION FROM AREA SOURCES                 CDM03370
C         PBAR: CALIBRATED CONTRIBUTION FROM POINT SOURCES                CDM03380
C         BKGR: INPUT BACKGROUND CONCENTRATIONS                           CDM03390
C         CCON: TOTAL CALIBRATED CONCENTRATION                            CDM03400
       IF (IPNCH.LE.0) GO TO 460                                          CDM03410
C                                                                         CDM03420
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
C  PUNCH OUTPUT                                                   CDM03430
      PUX=(RX-XGG)/RATG+1.                                        CDM03440
C        PUX: X COORDINATE OF PLOTTING GRID                       CDM03450
      PUY=(RY-YGG)/RATG+1.                                        CDM03460
C        PUY: Y COORDINATE OF PLOTTING GRID                       CDM03470
C        KPX: CARD OUTPUT VECTOR                                  CDM03480
      KPX(1)=ABAR(1)+0.5                                          CDM03490
      KPX(2)=ABAR(2)+0.5                                          CDM03500
      KPX(3)=PBAR(1)+0.5                                          CDM03510
      KPX(4)=PBAR(2)+0.5                                          CDM03520
      KPX(5)=BKGR(1)+0.5                                          CDM03530
      KPX(6)=BKGR(2)+0.5                                          CDM03540
      KPX(7)=CCON(1)+0.5                                          CDM03550
      KPX(8)=CCON(2)+0.5                                          CDM03560
      KPX(9)=COBS(1)                                              CDM03570
      KPX(10)=COBS(2)                                             CDM03580
      WRITE(IPU,405)PUX,PUY,(KPX(L),L=1,10),RX,RY,IRUN            CDM03590
  405 FORMAT(F8.2,F6.2,10I4,2F10.2,I5,'I')                        CDM03600
  460 IF(NROSE.LT.1) GOTO798                                      CDM03610
C                                                                 CDM03620
C  PRINT AREA AND POINT SOURCE ROSES                              CDM03630
      KPX(17)=RX*100.                                             CDM03640
      KPX(18)=RY*100.                                             CDM03650
      IF (IPG.LE.39) GO TO 469                                    CDM03660
      WRITE(IWR,441) IHD,ITIT,IRUN,NREC,NRAM                      CDM03670
      IPG = 5                                                     CDM03680
  469 IPG = IPG + 13                                              CDM03690
      WRITE(IWR,461) IWDR                                         CDM03700
  461 FORMAT('0',/,11X,9('****'),'  POINT ROSES (MICROGRAMS/CU. ',  CDM03710
     X  'METER)  *',9('****'),//,11X,                              CDM03720
     X  'CARD ID',5X,16(2X,A4))                                    CDM03730
      DO 463 J=1,NPOL                                             CDM03740
      DO462I=1,16                                                 CDM03750
      IF (TCON(J).EQ.0.) GO TO 462                                CDM03760
      PROSE(I,J)=CB(J)*PROSE(I,J)+CA(J)*PROSE(I,J)/TCON(J)        CDM03770
  462 KPX(I)=PROSE(I,J)+0.5                                       CDM03780
      WRITE(IWR,467) PROS(J),LPNAM(J),(PROSE(I,J),I=1,16)         CDM03790
      IF (NROSE.EQ.2) WRITE(IPU,464)PROS(J),KPX                   CDM03800
  467 FORMAT(' ',8X,A4,' (',A4,')',2X,16F6.1)                     CDM03810
  464 FORMAT(A4,16I4,2I6)                                         CDM03820
  463 CONTINUE                                                    CDM03830
      WRITE(IWR,468) IWDR                                         CDM03840
  468 FORMAT('0',10X,9('****'),'*  AREA ROSES (MICROGRAMS/CU. ',  CDM03850
     X  'METER)  *',9('****'),//,11X,                              CDM03860
     X  'CARD ID',5X,16(2X,A4))                                    CDM03870
      DO 466 L=1,NPOL                                             CDM03880
      DO465K=1,16                                                 CDM03890
      IF (TCON(L).EQ.0.) GO TO 465                                CDM03900
      AROSE(K,L)=CB(L)*AROSE(K,I)+CA(L)*AROSE(K,L)/TCON(L)        CDM03910
  465 KPX(K)=AROSE(K,L)+0.5                                       CDM03920
      WRITE(IWR,467) AROS(L),LPNAM(L),(AROSE(K,L),K=1,16)         CDM03930
      IF (NROSE.EQ.2) WRITE(IPU,464)AROS(L),KPX                   CDM03940
  466 CONTINUE                                                    CDM03950
  798 IF (NCULP.EQ.0) GO TO 700                                   CDM03960
C                                                                 CDM03970
C  CALIBRATE SOURCE CONTRIBUTIONS                                 CDM03980
  509 DO 520 ICU=1,NPC                                            CDM03990
```

Figure E.1. CEMQC FORTRAN Listing. Main Program, continued.

```
      IC = IPC(ICU)                                                     CDM04000
      IF (TCON(IC).EQ.0.) GC TO 520                                     CDM04010
      DO 510 ICC=1,IAS                                                  CDM04020
  510 ZSOUPC(ICC,IC) = ZSOURC(ICC,IC)*CB(IC) +                          CDM04030
     X  CA(IC)*ZSOURC(ICC,IC)/TCON(IC)                                  CDM04040
      DC 515 IPP=1,IPS                                                  CDM04050
  515 PCINTS(IPP,IC) = POINTS(IPP,IC)*CB(IC) +                          CDM04060
     X  CA(IC)*POINTS(IPP,IC)/TCON(IC)                                  CDM04070
  520 CONTINUE                                                          CDM04080
C                                                                       CDM04090
C  PRINT CULPABILITY LIST(S)                                            CDM04100
      IF (IPG.LE.39) GO TO 522                                          CDM04110
      IPG = 5                                                           CDM04120
      WRITE(IWR,441) IHD,ITIT,IPUN,NREC,NRAM                            CDM04130
  522 WRITE(IWR,523)                                                    CDM04140
  523 FCRMAT('0',/,11X,9('*****'),'**  INDIVIDUAL SOURCE CONTRIBUTIONS', CDM04150
     X  '  **',9('*****'),/)                                            CDM04160
      IF (NCULP.EQ.3) GO TO 530                                         CDM04170
      IC = IPC(1)                                                       CDM04180
      WRITE(IWR,525) LPNAM(IC)                                          CDM04190
  525 FORMAT(51X,'POLLUTANT: ',A4,//,44X,'MICROGRAMS/',8X,'PERCENTAGE', CDM04200
     X  /,45X,'CU. METER',10X,'OF TOTAL')                               CDM04210
      GC TC 540                                                         CDM04220
  530 WRITE(IWR,535) LPNAM                                              CDM04230
  535 FORMAT(51X,'POLLUTANT: ',A4,25X,'POLLUTANT: ',A4,//,44X,          CDM04240
     X  'MICRCGRAMS/',8X,'PERCENTAGE',12X,'MICROGRAMS/',8X,'PERCENTAGE',CDM04250
     X  /,45X,'CU. METER',10X,'OF TOTAL',14X,'CU. METER',10X,           CDM04260
     X  'OF TOTAL')                                                     CDM04270
  540 IPG = IPG + 8                                                     CDM04280
      IF (IPS.EQ.0) GO TO 555                                           CDM04290
      WRITE(IWR,542)                                                    CDM04300
  542 FCRMAT('0',15X,'POINT SOURCES',/)                                 CDM04310
      IPG = IPG + 3                                                     CDM04320
      DO 550 IPP=1,IPS                                                  CDM04330
      IF (IPG.LE.54) GO TO 551                                          CDM04340
      IPG = 16                                                          CDM04350
      WRITE(IWR,441) IHD,ITIT,IPUN,NREC,NRAM                            CDM04360
      WRITE(IWP,523)                                                    CDM04370
      IF (NCULP.EQ.3) GO TO 549                                         CDM04380
      IC = IPC(1)                                                       CDM04390
      WRITE(IWR,525) LPNAM(IC)                                          CDM04400
      GC TO 543                                                         CDM04410
  549 WRITE(IWR,535) LPNAM                                              CDM04420
  543 WRITE(IWR,542)                                                    CDM04430
  551 DC 548 ICU=1,NPC                                                  CDM04440
      IC = IPC(ICU)                                                     CDM04450
      IF (TCCN(IC).NE.0.) GC TO 421                                     CDM04460
      PERC = 0.                                                         CDM04470
      GC TO 422                                                         CDM04480
  421 PERC = POINTS(IPP,IC)/CCON(IC)*100.0                              CDM04490
  422 IF (PERC.LT.CTOP) GO TO 547                                       CDM04500
      IF (ICU.EQ.1) IPG = IPG + 1                                       CDM04510
      IF (ICU.EQ.1) WRITE(IWR,545) IPP,POINTS(IPP,IC),PERC              CDM04520
  545 FORMAT(' ',18X,I4,'P',20X,F10.2,10X,F6.2)                         CDM04530
      IF (ICU.EQ.2) WRITE(IWR,546) POINTS(IPP,IC),PERC                  CDM04540
  546 FCRMAT('+',84X,F10.2,10X,F6.2)                                    CDM04550
      GC TO 548                                                         CDM04560
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
547 PCERC(IC) = PCERC(IC) + PERC                                         CDM04570
    PCBAR(IC) = PCBAR(IC) + POINTS(IPP,IC)                              CDM04580
548 CONTINUE                                                            CDM04590
550 CONTINUE                                                            CDM04600
555 IF (IAS.EQ.0) GO TO 570                                             CDM04610
    IF (IPG.LE.47) GO TO 554                                            CDM04620
    IPG = 13                                                            CDM04630
    WRITE(IWR,441) IHD,ITIT,IRUN,NREC,NRAM                              CDM04640
    WRITE(IWR,523)                                                      CDM04650
    IF (NCULP.EQ.3) GO TO 559                                           CDM04660
    IC = IPC(1)                                                         CDM04670
    WRITE(IWR,525) LPNAM(IC)                                            CDM04680
    GO TO 554                                                           CDM04690
559 WRITE(IWR,535) LPNAM                                                CDM04700
554 WRITE(IWR,556)                                                      CDM04710
556 FORMAT('0',15X,'AREA SOURCES',/)                                    CDM04720
    IPG = IPG + 3                                                       CDM04730
    DO 565 IDUM=1,IAS                                                   CDM04740
    IF (IPG.LE.54) GO TO 561                                            CDM04750
    IPG = 16                                                            CDM04760
    WRITE(IWR,441) IHD,ITIT,IRUN,NREC,NRAM                              CDM04770
    WRITE(IWR,523)                                                      CDM04780
    IF (NCULP.EQ.3) GO TO 571                                           CDM04790
    IC = IPC(1)                                                         CDM04800
    WRITE(IWR,525) LPNAM(IC)                                            CDM04810
    GO TO 557                                                           CDM04820
571 WRITE(IWR,535) LPNAM                                                CDM04830
557 WRITE(IWR,556)                                                      CDM04840
561 DO 563 ICU=1,NPC                                                    CDM04850
    IC = IPC(ICU)                                                       CDM04860
    IF (TCON(IC).NE.0.) GO TO 423                                       CDM04870
    PERC = 0.                                                           CDM04880
    GO TO 424                                                           CDM04890
423 PERC = ZSOURC(IDUM,IC)/CCON(IC)*100.0                               CDM04900
424 IF (PERC.LT.CTOF) GO TO 562                                         CDM04910
    IF (ICU.EQ.1) IPG = IPG + 1                                         CDM04920
    IF (ICU.EQ.1) WRITE(IWR,560) IDUM,ZSOURC(IDUM,IC),PERC              CDM04930
560 FORMAT(' ',18X,I4,'A',20X,F10.2,10X,F6.2)                           CDM04940
    IF (ICU.EQ.2) WRITE(IWR,546) ZSOURC(IDUM,IC),PERC                   CDM04950
    GO TO 563                                                           CDM04960
562 PCERC(IC) = PCERC(IC) + PERC                                        CDM04970
    PCBAR(IC) = PCBAR(IC) + ZSOURC(IDUM,IC)                             CDM04980
563 CONTINUE                                                            CDM04990
565 CONTINUE                                                            CDM05000
570 IF (IPG.LE.44) GO TO 573                                            CDM05010
    IPG = 16                                                            CDM05020
    WRITE(IWR,441) IHD,ITIT,IRUN,NREC,NRAM                              CDM05030
    WRITE(IWR,523)                                                      CDM05040
    IF (NCULP.EQ.3) GO TO 582                                           CDM05050
    IC = IPC(1)                                                         CDM05060
    WRITE(IWR,525) LPNAM(IC)                                            CDM05070
    GO TO 573                                                           CDM05080
582 WRITE(IWR,535) LPNAM                                                CDM05090
573 IPG = IPG + 7                                                       CDM05100
    WRITE(IWR,572) CTOF                                                 CDM05110
572 FORMAT('0',15X,'SOURCES INDIVIDUALLY CON-',/,16X,                   CDM05120
   X 'TRIBUTING LESS THAN ',F5.2,'%')                                   CDM05130
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
      IC = IPC(1)                                                       CDM05140
      WRITE(IWR,574) PCBAR(IC),PCERC(IC)                                CDM05150
  574 FORMAT('+',43X,F10.2,10X,F6.2)                                    CDM05160
      IF (NFC.EQ.1) GO TO 580                                           CDM05170
      IC = IPC(2)                                                       CDM05180
      WRITE(IWR,546) PCBAR(IC),PCERC(IC)                                CDM05190
  580 IC = IPC(1)                                                       CDM05200
      IF (CCON(IC).NE.0.) GO TO 425                                     CDM05210
      PERC = 0.                                                         CDM05220
      GO TO 426                                                         CDM05230
  425 PERC = BKGR(IC)/CCON(IC)*100.0                                    CDM05240
  426 WRITE(IWR,581) BKGR(IC),PERC                                      CDM05250
  581 FORMAT('0',15X,'BACKGROUND',18X,F10.2,10X,F6.2)                   CDM05260
      IF (NFC.EQ.1) GO TO 590                                           CDM05270
      IC = IPC(2)                                                       CDM05280
      IF (CCON(IC).EQ.0.) GO TO 427                                     CDM05290
      PERC = BKGR(IC)/CCON(IC)*100.0                                    CDM05300
  427 WRITE(IWR,546) BKGR(IC),PERC                                      CDM05310
  590 IC = IPC(1)                                                       CDM05320
      PERC = 100.00                                                     CDM05330
      WRITE(IWR,592) CCON(IC),PERC                                      CDM05340
  592 FORMAT('0',15X,'TOTAL',23X,F10.2,10X,F6.2)                        CDM05350
      IF (NFC.EQ.1) GO TO 700                                           CDM05360
      IC = IPC(2)                                                       CDM05370
      WRITE(IWR,546) CCON(IC),PERC                                      CDM05380
  700 IF (JFLG) 401,401,299                                             CDM05390
C                                                                       CDM05400
  404 CONTINUE                                                          CDM05410
C  PRINT STANDARD RESULTS FOR EACH RECEPTOR                             CDM05420
      CALL RECPR                                                        CDM05430
C  CARRY OUT LARSEN STATISTICAL ANALYSIS                                CDM05440
      CALL STAV                                                         CDM05450
  403 CALL EXIT                                                         CDM05460
      END                                                               CDM05470
```

Figure E.1. CDMQC FORTRAN Listing. Main Program, continued.

```
      SUBROUTINE CLINT
      COMMON /DISPLA/ ZSOURC(2500,2)
      COMMON /TABLE/ IIA(50,50)
      COMMON /C1/ K,MX,NN,HT,F(6,6,16),G(6,5),U(6),RI,RJ,INC(4),DELR
      COMMCN /C2/ UE(6),YD,YN,THN,HMIN,DINT,YCON,TA(4),IPG,XG,YG,IRD
      COMMON /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG
      COMMCN /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVER,IWR
      COMMON /C5/ Q(100,4),GA(2),IAD(4,5),XGG,YGG,IAS,TDA,TDB,TDC,IPU
      CCMMON /C6/ NROSE,NCUIP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,
     X            IHD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA
      COMMON /QCOM/ N,DR,IX,IY,TT(16,21),KTC,IXX,IYY,RAD,Z(50,50,3),TD
      CCMMON /ACOM/ PI,SZA(6),ABAR(2),AROSE(16,2),XS(6)
      CCMMON /PCOM/ PH(200),PR(200),PS(200,4),PX(200),PY(200),FB(200),
     *XX(200),DHF(2C0),WA(16),WP(16),PROSE(16,2),CV,IPS,RAT,TOA,PBAR(2),
     *PCINTS(200,2)
      COMMON /REG/ IFLG,NCAIR,IOCAL,NCL,NCL1,NCL2,RXS(200),RYS(200),
     X            CBS(200,2),SGDS(200,2),IPNCHS(50),NROSES(50),
     X            NCULPS(50),NLARSS(200),NRAMS(200),CALC(200,2),
     X            KPLG,JPLG,COBS(2),NRAM,CORREL(100),BKGR(2),RX,RY,
     X            TOTC(200,2)
      CCMMON/LARS/SGD(2),PAV(3,2),CCON(2),NLARS
      DATA IBLNK/'    '/
      ICHA = 0
C        SUBROUTINE CLEARS AND INITIALIZES.
      DC 10 I=1,50
      DC 10 J=1,50
      IIA(I,J)=0
   10 CCNTINUE
      DC533I=1,50
      DC533J=1,50
C        EFFECTIVE STACK HEIGHT MUST BE GE 1.
      Z(I,J,3)=1.
      DC533K=1,2
  533 Z(I,J,K)=0.
C        U(N): CENTER SPEED OF SIX WIND SPEED CLASSES
      TK(1)=0.
      DC544I=2,16
  544 TK(I)=TK(I-1)+22.5
C        UE(N): EXPONENTIAL OF WIND PROFILE.  0.001 = NO PROFILE.
C            N = STABILITY CLASS
      READ(5,543) ITIT
  543 FORMAT(20A4)
      READ(5,545)AROS,PROS,IRUN,NLIST1,NLIST2,IRD,IWR,IPU,CA,CB
C        AROS,PROS: OUTPUT CARD IDENTIFIERS
C        IRUN: IDENTIFICATION NUMBER
C        NLIST: INPUT LIST OPTION.  NLIST LE ZERO PRODUCES LIST
C        CA,CB: INTERCEPT, SLOPE OF CALIBRATION
  545 FORMAT(4A4,I5,1X,2I2,3I5,4F9.0)
      READ(IRD,546) NCALR,ICCAL,BKGR,LPNAM,PAV,CTOF
  546 FCRMAT(I6,1X,I4,1X,2F10.0,2(1X,A4),2(1X,3F4.0),1X,F5.0)
C        NCALR: TOTAL NUMBER OF RECEPTORS TO BE USED IN CALIBRATION
C        ICCAL: PARAMETER INDICATING CALIBRATION OPTION TO BE USED
C        BKGR(N): BACKGROUND CONCENTRATION, MICROGRAMS/M**3
C          N = 1 : P1 ; N=2 : P2
C        LPNAM(N): POLLUTANT NAMES
C          N = 1 : P1 ; N=2 : P2
C        PAV(3,N): UP TO THREE AVERAGING TIMES(HOURS) FOR LARSEN
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT.

```
C               STATISTICAL ANALYSIS
C               N = 1 : P1 : N = 2 : P2                                 CLI00580
C          CTOF: PERCENTAGE FOR CULPABILITY LISTS; SOURCES CONTRIBUTING CLI00590
C               LESS THAN THIS VALUE WILL NOT BE INDIVIDUALLY LISTED    CLI00600
      IF (IOCAL.NE.0.AND.NCALR.NE.0) JFLG = 1                           CLI00610
      IF (LPNAM(2).EQ.IBLNK) NPOL = 1                                   CLI00620
C       INPUT MODEL PARAMETERS                                          CLI00630
      READ(IRD,504)DELR,RAT,CV,HT,HMIN,XG,YG,XGG,YGG,RATG,TOA,TXX       CLI00640
C          DELR: INTEGRATION INCREMENT (RADIAL DISTANCE (M))            CLI00650
C          RAT: RATIO, EMISSION GRID TO MAP GRID                        CLI00660
C          HT: AVERAGE AFTERNOON MIXING HEIGHT (M)                      CLI00670
C          CV: CONVERSION, CV*RAT = EMISSION GRID INTERVAL (M)          CLI00680
C          HMIN: NOCTURNAL MIXING HEIGHT (M)                            CLI00690
C          XG: MAP COORDINATE X, SOUTHWEST CORNER OF EMISSION GRID      CLI00700
C          YG: MAP COORDINATE Y, SOUTHWEST CORNER OF EMISSION GRID      CLI00710
C          XGG: MAP COORDINATE X, SOUTHWEST CORNER OF PLOTTING GRID     CLI00720
C          YGG: MAP COORDINATE Y, SOUTHWEST CORNER OF PLOTTING GRID     CLI00730
C          RATG: RATIC, EMISSION GRID TO MAP GRID                       CLI00740
C          TCA: MEAN AMBIENT TEMPERATURE (C)                            CLI00750
C          TXX: WIDTH OF A BASIC AREA SOURCE SQUARE (M)                 CLI00760
  504 FORMAT(12F6.0)                                                    CLI00770
      IF (TXX.EQ.0.) GO TO 508                                          CLI00780
      CHK = ABS(1.0-(RAT*CV/TXX))                                       CLI00790
      IF (CHK.LE.0.01) GO TO 507                                        CLI00800
  508 ICHA = 1                                                          CLI00810
C  COMPUTE MAXIMUM LENGTH (M) OF SIDE OF EMISSION GRID SQUARE MATRIX    CLI00820
  507 TXXT = 50. * TXX                                                  CLI00830
      READ(IRD,504)DINT,YD,YN,SZA,GB                                    CLI00840
C          DINT: NUMBER OF SEGMENTS DESIRED IN 22.5 DEG. SECTORS..      CLI00850
C               RANGE 2 TO 20 INCLUSIVE.                                CLI00860
C          YD: RATIO, AVG. DAYTIME EMISSION / 24-HR EMISSION            CLI00870
C          YN: RATIO, AVG. NIGHTTIME EMISSION / 24-HR EMISSION          CLI00880
C          SZA(N): INITIAL SIGMA Z FOR AREA SOURCES (M)                 CLI00890
C             N = STABILITY CLASS                                       CLI00900
C          GB(N): DECAY RATE HALF LIFE                                  CLI00910
C            N=1:  P 1,  N=2:  P 2                                      CLI00920
C        INPUT RELATIVE FREQUENCY TABLE OF STABILITY,WIND SPEED, AND DIRECLI00930
      DO513I=1,6                                                        CLI00940
      DO513K=1,16                                                       CLI00950
  513 READ(IRD,514)(F(I,J,K),J=1,6)                                     CLI00960
C          F(I,J,K): JOINT FREQUENCY FUNCTION...                        CLI00970
C             I = STABILITY CLASS                                       CLI00980
C             J = WIND SPEED CLASS                                      CLI00990
C             K = WIND DIRECTION                                        CLI01000
  514 FORMAT(7X,6F7.0)                                                  CLI01010
      TOA=TCA+273.16                                                    CLI01020
      DR=DELR/(CV*RAT)                                                  CLI01030
      KTC=DINT+1.                                                       CLI01040
      THETA=22.5/DINT                                                   CLI01050
      DO519I=1,16                                                       CLI01060
      B=TK(I)/RAD                                                       CLI01070
      WB(I)=SIN(B)                                                      CLI01080
      WA(I)=COS(B)                                                      CLI01090
      DO519J=1,KTC                                                      CLI01100
      X=TANG-TK(I)+(J-1)*THETA                                          CLI01110
      IF(X.LT.0.) X=X+360.                                              CLI01120
  519 TT(I,J)=X/RAD                                                     CLI01130
                                                                        CLI01140
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT, continued.

```
C       DEFINE HALF LIFE FOR P 1 AND  P 2                               CLI01150
      DO520I=1,NPOL                                                     CLI01160
  520 GA(I)=GB(I)*3600./0.693                                           CLI01170
      H(1)=HT*1.5                                                       CLI01180
      H(2)=HT                                                           CLI01190
      H(3)=HT                                                           CLI01200
      H(4)=HT                                                           CLI01210
      H(5)=(HT+HMIN)*0.5                                                CLI01220
      H(6)=HMIN                                                         CLI01230
      DO114JA=1,6                                                       CLI01240
      JB=ICA(JA)                                                        CLI01250
      HX(JA)=0.8*H(JA)                                                  CLI01260
      SA=SZA(JA)                                                        CLI01270
      IF(SA.GT.0.) GOTO110                                              CLI01280
      S=0.                                                              CLI01290
      GOTO114                                                           CLI01300
  110 S=(SA/G(1,JB))**(1./G(4,JB))                                      CLI01310
      IF(S.GE.5000.) GOTO114                                            CLI01320
      S=(SA/G(2,JB))**(1./G(5,JB))                                      CLI01330
      IF(S.GE.500.) GOTO114                                             CLI01340
      S=(SA/G(3,JB))**(1./G(6,JB))                                      CLI01350
  114 XS(JA)=S                                                          CLI01360
C                                                                       CLI01370
C  PRINT TITLE PAGE                                                     CLI01380
      WRITE(IWR,800) IHD,ITIT,IRUN                                      CLI01390
  600 FORMAT('1',35X,16A4,//,26X,20A4,/,61X,'RUN ',I5)                  CLI01400
      WRITE(IWR,801)                                                    CLI01410
  801 FORMAT('0',/,1X,'POLLUTANTS TO BE MODELED:',/)                    CLI01420
      DO 803 I=1,NPOL                                                   CLI01430
      WRITE(IWR,802) I,LPNAM(I)                                         CLI01440
  802 FORMAT(5X,I1,') ',A4)                                             CLI01450
  803 CONTINUE                                                          CLI01460
      WRITE(IWR,804) XG,YG,TXX,SZA,DINT,THETA,DELR,RAT,CV               CLI01470
  804 FORMAT('0',/,1X,'OPERATING PARAMETERS:',//,5X,                    CLI01480
     X  'X-MINIMUM OF AREA EMISSION INVENTORY MAP GRID (XG) ..',         CLI01490
     X  7('....'),1PE20.6,                                              CLI01500
     X  /,5X,'Y-MINIMUM OF AREA EMISSION INVESTORY MAP GRID (YG) ..',   CLI01510
     X  7('....'),E20.6,//,5X,'WIDTH OF BASIC AREA SOURCE SQUARE (TXX)' CLI01520
     X     1X,10('....'),'.',E20.6,' METERS',//,                        CLI01530
     X  5X,'INITIAL SIGMA Z (METERS) FOR AREA SOURCES (SZA):',//,10X,   CLI01540
     X  'STABILITY CLASS:',5X,'1 .',13('....'),3X,E17.6,/,31X,'2 .',    CLI01550
     X  13('....'),3X,E17.6,/,31X,'3 .',13('....'),3X,E17.6,/,31X,'4 .',CLI01560
     X  13('....'),3X,E17.6,/,31X,'5 .',13('....'),3X,E17.6,/,31X,'6 .',CLI01570
     X  13('....'),3X,E17.6,//,5X,                                      CLI01580
     X  'NUMBER OF SUBSECTORS CONSIDERED IN A 22.5 DEGREE SECTOR ',      CLI01590
     X  '(DINT) ..',4('....'),E20.6,/,5X,'ANGULAR WIDTH OF A SUBSECTOR',CLI01600
     X  ' (THETA) ',11('....'),E20.6,' DEGREES',//,5X,                  CLI01610
     X  'INITIAL RADIAL INCREMENT (DELR) .',12('....'),E20.6,' METERS', CLI01620
     X  //,5X,'RATIO OF EMISSION GRID TO MAP GRID (RAT) ',10('....'),   CLI01630
     X  E20.6,/,5X,'GRID CONVERSION FACTOR (CV) .',13('....'),E20.6)   CLI01640
      TTM = TOA-273.16                                                  CLI01650
      WRITE(IWR,807) HT,HMIN,TTM                                        CLI01660
  807 FORMAT('0',/,1X,'MISCELLANEOUS METEOROLOGICAL DATA:',//,5X,       CLI01670
     X  'AVERAGE AFTERNOON MIXING HEIGHT (HT) ',11('....'),1PE20.6,     CLI01680
     X  ' METERS',/,5X,'AVERAGE NOCTURNAL MIXING HEIGHT (HMIN) ..',     CLI01690
     X  10('....'),E20.6,' METERS',/,5X,'MEAN ATMOSPHERIC TEMPERATURE ',CLI01700
     X  '(TOA) ..',11('....'),E20.6,' DEGREES',                         CLI01710
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT, continued.

```
      X  ' CELSIUS',/)
       DO 809 I=1,NPOL
       WRITE(IWR,808) LPNAM(I),I,GB(I)
  808 FORMAT(5X,'DECAY HALF LIFE FOR ',A4,' (GB(',I1,')) ',12('....'),
      X  1PE20.6,' HOURS')
  809 CONTINUE
       WRITE(IWP,810) YD,YN
  810 FORMAT('0',/,1X,'RATIO (YD) OF AVERAGE DAYTIME EMISSION RATE TO ',
      X  'THE 24-HOUR EMISSION RATE AVERAGE ....',1PE20.6,/,1X,
      X  'RATIO (YN) OF AVERAGE NIGHTTIME EMISSION RATE TO THE 24-HOUR ',
      X  'EMISSION RATE AVERAGE ..',E20.6)
       WRITE(IWR,811)
  811 FORMAT('0',/,1X,'BACKGROUND CONCENTRATION (BKGR), ',
      X  'ARITHMETIC MEAN, FOR:',/)
       DO 814 I=1,NPOL
       WRITE(IWR,813) LPNAM(I),BKGR(I)
  813 FORMAT(5X,A4,1X,19('....'),1PE20.6,' MICROGRAMS/CU. METER')
  814 CONTINUE
       WRITE(IWP,800) IHD,ITIT,IRUN
       WRITE(IWR,815) CTOP
  815 FORMAT('0',/,1X,'ANY CULPABILITY LIST(S) WILL INDIVIDUALLY ',
      X  'LIST SOURCES CONTRIBUTING GREATER',/,1X,'THAN OR EQUAL TO ',
      X  F5.2,'% (CTOP) OF TOTAL CALIBRATED CONCENTRATION')
       ICC = ICCAL+1
       GO TO (820,830,840,850),IOC
  820 WRITE(IWP,821)
  821 FORMAT('0',/,1X,'(IOCAL=0) REGRESSION EQUATION CONSTANTS INPUT ',
      X  'WILL BE USED TO CALIBRATE COMPUTED CONCENTRATIONS:',/)
       DO 823 I=1,NPOL
  823 WRITE(IWR,822) LPNAM(I),I,CB(I),I,CA(I),I,BKGR(I)
  822 FORMAT('0',15X,'INPUT CONSTANTS FOR ',A4,':',/,
      X  20X,'SLOPE (CB(',I1,')) ...',2('....'),1PE20.6,/,20X,
      X  'Y-INTERCEPT (CA(',I1,')) .....',E20.6,' MICROGRAMS/CU. METER',
      X  /,20X,'BACKGROUND (BKGR(',I1,')) ....',E20.6,' MICROGRAMS/CU. ',
      X  'METER')
       GO TO 860
  830 WRITE(IWR,831) NCALR
  831 FORMAT('0',/,1X,'(IOCAL=1) REGRESSION EQUATION CONSTANTS WILL BE ',
      X  'DETERMINED BASED ON COMPUTED AND OBSERVED CONCENTRATIONS FOR',
      X  /,11X,'FIRST SET OF ',I3,' RECEPTORS INPUT;  IF COMPUTED ',
      X  'CORRELATION COEFFICIENT LESS THAN THEORETICAL VALUE, FOR ',/,
      X  11X,'EITHER POLLUTANT, PROCESSING WILL STOP;  IF COMPUTED ',
      X  'CORRELATION COEFFICIENT GREATER THAN OR EQUAL TO THEORETICAL ',
      X  /,11X,'VALUE, FOR BOTH POLLUTANTS, COMPUTED CONSTANTS WILL BE ',
      X  'USED TO CALIBRATE.')
       GO TO 860
  840 WRITE(IWR,841) NCALR
  841 FORMAT('0',/,1X,'(IOCAL=2) REGRESSION EQUATION CONSTANTS WILL ',
      X  'BE DETERMINED BASED ON COMPUTED AND OBSERVED CONCENTRATIONS ',
      X  'FOR',/,11X,'FIRST SET OF ',I3,' RECEPTORS INPUT;  IF COMPUTED '
      X  ,'CORRELATION COEFFICIENT LESS THAN THEORETICAL VALUE,',/,
      X  11X,'FOR EITHER POLLUTANT, DEFAULT REGRESSION COEFFICIENT ',
      X  'VALUES (INTERCEPT=0, SLOPE=1), TOGETHER WITH INPUT',/,
      X  11X,'BACKGROUND LEVELS, WILL BE USED TO CALIBRATE;  IF ',
      X  'COMPUTED CORRELATION COEFFICIENT GREATER THAN OR ',/,
      X  11X,'EQUAL TO THEORETICAL VALUE, FOR BOTH POLLUTANTS, COMPUTED '
      X  ,'CONSTANTS WILL BE USED TO CALIBRATE.')
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT, continued.

```
      GO TO 860
  850 WRITE(IWR,851) NCALR
  851 FORMAT('0',/,1X,'(IOCAL=3) REGRESSION EQUATION CONSTANTS WILL BE '
     X ,'DETERMINED BASED ON COMPUTED AND OBSERVED CONCENTRATIONS ',/,
     X  11X,'FOR FIRST SET OF ',I3,' RECEPTORS INPUT;  RESULTS OF ',
     X  'REGRESSION ANALYSIS WILL BE PRINTED AND PROCESSING WILL STOP.')
  860 IFL2 = 0
      DO 870 I=1,NPOL
      IFL = 0
      DO 862 L=1,3
      IF (PAV(L,I).NE.0.) IFL = 1
  862 CONTINUE
      IF (IFL.EQ.0) GO TO 870
      IF (IFL2.EQ.0) WRITE(IWR,865)
  865 FORMAT('0',/,1X,'LARSEN''S STATISTICAL MODEL WILL BE APPLIED ',
     X  'FOR THE FOLLOWING AVERAGING TIMES (PAV):',/)
      IFL2 = 1
      WRITE(IWR,866) LPNAM(I)
  866 FORMAT(5X,A4)
      DO 869 L=1,3
      IF (PAV(L,I).EQ.0.) GO TO 870
      WRITE(IWR,868) PAV(L,I)
  868 FORMAT(7X,F4.1,' HOURS')
  869 CONTINUE
  870 CONTINUE
      IF (IFL2.EQ.0) WRITE(IWR,871)
  871 FORMAT('0',/,1X,'LARSEN''S STATISTICAL MODEL WILL NOT BE ',
     X  'APPLIED FOR ANY AVERAGING TIMES')

      IF (NLIST1.GT.0) GO TO 501
C
C  PRINT WINDROSE DATA
      I = 0
      DO 799 NN=1,3
      WRITE(IWR,800) IHD,ITIT,IPUN
      WRITE(IWR,700)
  700 FORMAT('0',/,47X,'METEOROLOGICAL JOINT FREQUENCY FUNCTION')
      DO 780 N=1,2
      I = I+1
      WRITE(IWR,705) I
  705 FORMAT('0',/,1X,'STABILITY CLASS ',I1,52X,'W I N D   S P E E D  ',
     X  ' C L A S S',//,5X,'WIND DIRECTION',4X,'SECTOR',19X,
     X  '1',14X,'2',14X,'3',14X,'4',14X,'5',14X,'6',/)
      DO 750 K=1,16
  750 WRITE(IWR,710) IWDR(K),K,(F(I,J,K),J=1,6)
  710 FORMAT(11X,A4,10X,I2,14X,6(4X,F8.6,3X))
  780 CONTINUE
  799 CONTINUE
C
C  SOURCE INPUT VARIABLES:
C        X: COORDINATE (SW CORNER OF GRID CELL IF AREA SOURCE)
C        Y: COORDINATE (SW CORNER OF GRID CELL IF AREA SOURCE)
C        SH: STACK HEIGHT (M)
C        S1: SOURCE EMISSION RATE (P 1 IN GRAMS/SECOND)
C        S2: SOURCE EMISSION RATE ( P 2 IN GRAMS/SECOND)
C        SA: FOR POINT SOURCES, IF BLANK, BRIGGS FORMULA USED, IF NOT
C            BLANK, SH*WIND SPEED IS USED.
C
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT, continued.

```
C         TX:  WIDTH OF AREA SOURCE CELL (M)                          CLI02860
C         D: STACK DIAMETER (M)                                       CLI02870
C         T: STACK GAS TEMPERATURE (C)                                CLI02880
C         VS: STACK GAS EXIT VELOCITY (M/S)                           CLI02890
C  INPUT POINT SOURCE DATA                                            CLI02900
  501 READ(IRD,502)X,Y,S1,S2,SH,D,VS,T,SA                             CLI02910
  502 FORMAT(F6.0,F7.0,7X,2F8.0,F7.0,F5.0,2F7.0,F5.0)                 CLI02920
C  TEST END OF POINT SOURCE DATA (BLANK CARD)                         CLI02930
      IF (S1+S2.LE.C.) GO TO 503                                      CLI02940
      IPS = IPS+1                                                     CLI02950
      IF(NLIST2.GT.0) GOTO888                                         CLI02960
      IF (IPG.LE.54) GO TO 620                                        CLI02970
      WRITE(IWR,600) IHD,ITIT,IRUN                                    CLI02980
  600 FORMAT('1',35X,16A4,//,26X,20A4,/,61X,'RUN ',I5,//,             CLI02990
     X  51X,'AREA AND POINT SOURCE INVENTORY')                        CLI03000
      WRITE(IWR,602) LPNAM                                            CLI03010
  602 FORMAT(//,96X,'STACK',9X,'STACK',7X,'OPTIONAL',/,               CLI03020
     X  38X,'EMISSION RATE',3X,'EMISSION RATE',4X,'STACK',6X,'STACK', CLI03030
     X  9X,'EXIT',11X,'GAS',7X,'PLUME RISE',/,3X,                     CLI03040
     X  'POINT',7X,'X MAP',8X,'Y MAP',8X,'FOR ',A4,8X,'FOR ',A4,      CLI03050
     X  6X,'HEIGHT',6X,'DIAM',9X,'SPEED',9X,'TEMP',6X,                CLI03060
     X  'COEFFICIENT',/,1X,'SOURCE ID',2(3X,'COORDINATE'),3X,         CLI03070
     X  '(GRAMS/SEC)',5X,'(GRAMS/SEC)',1X,2(3X,'(METERS)'),3X,        CLI03080
     X  '(METERS/SEC)',3X,'(DEG CELS)',1X,'(SQ METERS/SEC)',/)        CLI03090
      IPG = 13                                                        CLI03100
  620 IPG = IPG + 1                                                   CLI03110
      WRITE(IWR,625) IPS,X,Y,S1,S2,SH,D,VS,T,SA                       CLI03120
  625 FORMAT(2X,I4,'P',4X,F10.2,3X,F10.2,2X,F13.2,3X,F13.2,2(1X,F10.2), CLI03130
     X  2X,F13.2,3X,F10.2,3X,F10.2)                                   CLI03140
C         EFFECTIVE STACK HEIGHT MUST BE GE 1.                        CLI03150
  888 IF(SH.LT.1.) SH=1.                                              CLI03160
C         STORE POINT SOURCE DATA                                     CLI03170
  510 PX(IPS)=(X-XG)/RAT+0.5                                          CLI03180
      PY(IPS)=(Y-YG)/RAT+0.5                                          CLI03190
      PS(IPS,1)=S1*2.03                                               CLI03200
      PS(IPS,2)=S2*2.03                                               CLI03210
      PS(IPS,3)=S1*2.55                                               CLI03220
      PS(IPS,4)=S2*2.55                                               CLI03230
      PH(IPS)=SH                                                      CLI03240
      PR(IPS)=SA                                                      CLI03250
      IF(SA.GT.0.) GOTO501                                            CLI03260
      D=D*0.5                                                         CLI03270
      T=T+273.16                                                      CLI03280
      S=(T-TOA)/T*9.8*VS*D*D                                          CLI03290
      IF(S.GT.55.) GOTO606                                            CLI03300
      XX(IPS)=14.*S**0.625                                            CLI03310
      GOTO605                                                         CLI03320
  606 XX(IPS)=34.*S**0.4                                              CLI03330
  605 FB(IPS)=1.6*S**0.3333                                           CLI03340
      DHF(IPS)=FB(IPS)*(3.5*XX(IPS))**0.6667                          CLI03350
      GOTO501                                                         CLI03360
C                                                                     CLI03370
  503 CONTINUE                                                        CLI03380
C  INITIALIZE FLAG FOR AREA SOURCE ERROR MESSAGE                      CLI03390
      IEP = 0                                                         CLI03400
      IF (IPS.NE.0.OR.NLIST2.GT.0) GO TO 506                          CLI03410
      WRITE(IWR,600) IHD,ITIT,IRUN                                    CLI03420
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT, continued.

```
      IPG = 6                                                           CLI03430
C  INPUT AREA SOURCE DATA                                               CLI03440
  506 READ(IPC,505) X,Y,TX,S1,S2,SH                                     CLI03450
  505 FORMAT(F6.0,2F7.0,2F8.0,F7.0)                                     CLI03460
C  TEST END OF AREA SOURCE DATA (BLANK CARD)                            CLI03470
      IF (S1+S2.LE.0.) GO TO 900                                        CLI03480
      IAS = IAS + 1                                                     CLI03490
      IF (MLIST2.GT.0) GO TO 899                                        CLI03500
      IF (IAS.NE.1.AND.IPG.LE.48) GO TO 640                             CLI03510
      IF ((IAS.NE.1.OR.IPG.LT.33).AND.IPG.LE.48) GO TO 629              CLI03520
      IPG = 6                                                           CLI03530
      WRITE(IWR,600) IHD,ITIT,IFUN                                      CLI03540
  629 WRITE(IWR,630) LPNAM                                              CLI03550
  630 FORMAT(///,16X,'X MAP',9X,'Y MAP',7X,'WIDTH OF',5X,               CLI03560
     X  'EMISSION RATE',3X,'EMISSION RATE',3X,'EMISSION',/,3X,          CLI03570
     X  'AREA',6X,2('COORD OF SW',3X),'GRID SQUARE',6X,'FOR ',A4,7X,    CLI03580
     X  'FOR ',A4,7X,'HEIGHT',/,1X,'SOURCE ID',2(3X,'GRID CORNER'),     CLI03590
     X  4X,'(METERS)',6X,'(GRAMS/SEC)',5X,'(GRAMS/SEC)',4X,             CLI03600
     X  '(METERS)',/)                                                   CLI03610
      IPG = IPG + 7                                                     CLI03620
  640 IPG = IPG + 1                                                     CLI03630
      WRITE(IWR,645) IAS,X,Y,TX,S1,S2,SH                                CLI03640
  645 FORMAT(2X,I4,'A',5X,2(F10.2,4X),F11.2,3X,F10.2,6X,F10.2,4X,F10.2) CLI03650
C         EFFECTIVE STACK HEIGHT MUST BE GE 1.                          CLI03660
  899 IF (SH.LT.1.) SH=1.                                               CLI03670
C        STCRE AREA SOURCE DATA                                         CLI03680
C         MCVE COORDINATE TO CENTER OF GRID CELL                        CLI03690
      D=TX*0.5/CV                                                       CLI03700
      XSS = X                                                           CLI03710
      YSS = Y                                                           CLI03720
      X=X+D                                                             CLI03730
      Y=Y+D                                                             CLI03740
      W=TX/TXX                                                          CLI03750
      S=TX*TX                                                           CLI03760
      B=S1/S                                                            CLI03770
      D=S2/S                                                            CLI03780
C        BECAUSE OF THE METHOD OF INTEGRATION, AREA SOURCES ARE         CLI03790
C        DIVIDED BY TWO AT THIS PCINT FOR MORE EFFICIENT EXECUTION      CLI03800
C        OF SUBROUTINE AREA.                                            CLI03810
      B=B*0.5                                                           CLI03820
      D=D*0.5                                                           CLI03830
      X=(X-XG)/RAT+1.                                                   CLI03840
      Y=(Y-YG)/RAT+1.                                                   CLI03850
      IF(W.GT.1.) GOTO531                                               CLI03860
      M=X                                                               CLI03870
      N=Y                                                               CLI03880
      K=M                                                               CLI03890
      L=N                                                               CLI03900
      GOTC539                                                           CLI03910
  531 S=W*0.5                                                           CLI03920
      K=(X-S)+0.55                                                      CLI03930
      L=(Y-S)+0.55                                                      CLI03940
      M=(K+W)-0.45                                                      CLI03950
      N=(L+W)-0.45                                                      CLI03960
  539 CCNTINUE                                                          CLI03970
      IF (M.LE.50.AND.N.LE.50) GO TO 540                                CLI03980
C  PRINT ERRCR MESSAGE FOR THIS AREA SOURCE                             CLI03990
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT, continued.

```
      IF (IER.EQ.0.AND.NLIST2.GT.0) WRITE(IWR,800) IHD,ITIT,IRUN        CLI04000
      WRITE(IWR,541) IAS,XSS,YSS,TXXT,IAS                               CLI04010
  541 FORMAT('0',7X,'NOTE:  AREA SOURCE ',I4,'A, WITH X COORD ',F10.2,  CLI04020
     X ' AND Y COORD ',F10.2,', VIOLATES',/,15X,                        CLI04030
     X 'AREA SOURCE ARRAY LIMITS.  AREA SOURCES MUST LIE ENTIRELY ',    CLI04040
     X 'WITHIN A ',F11.2,/,15X,                                         CLI04050
     X 'METER SQUARE WITH SOUTHWEST CORNER AT THE USER-DEFINED ',       CLI04060
     X 'ORIGIN (XG,YG).  AREA',/,15X,                                   CLI04070
     X 'SOURCE ',I4,'A WILL NOT BE INCLUDED IN THIS CALCULATION.',/)    CLI04080
      IPG = IPG + 6                                                     CLI04090
      GO TO 506                                                         CLI04100
  540 DO532I=K,M                                                        CLI04110
      DO532J=L,N                                                        CLI04120
      IIA(I,J)=IAS                                                      CLI04130
      Z(I,J,1)=B                                                        CLI04140
      Z(I,J,2)=D                                                        CLI04150
  532 Z(I,J,3)=SH                                                       CLI04160
      IF(M.GT.IXX) IXX=M                                                CLI04170
      IF(N.GT.IYY) IYY=N                                                CLI04180
      GO TO 506                                                         CLI04190
  900 TDA=0.5-TD                                                        CLI04200
      IDA=0.5-TD                                                        CLI04210
      TDB=IXX+0.5+TD                                                    CLI04220
      TDC=IYY+0.5+TD                                                    CLI04230
      IF (IAS.EQ.0.OR.ICHA.EQ.0) GO TO 903                              CLI04240
C  PRINT ERROR MESSAGE FOR AREA SOURCE INPUT PARAMETERS                 CLI04250
      IF (IPG.LE.52) GO TO 901                                          CLI04260
      WRITE(IWP,800) IHD,ITIT,IRUN                                      CLI04270
  901 WRITE(IWP,902)                                                    CLI04280
  902 FORMAT('0',/,1X,'INPUT ERROR:  RAT*CV MUST EQUAL IXX. ',          CLI04290
     X 'CALCULATION TERMINATED.')                                       CLI04300
      RETURN                                                            CLI04310
  903 ICHA = 0                                                          CLI04320
      RETURN                                                            CLI04330
      END                                                               CLI04340
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CLINT, continued.

```
      SUBROUTINE CALQ
      DIMENSION C(3)
      COMMON /TABUL/ IQ(100,21,4),QZBAR(100,21,2)
      COMMON /C1/ K,MX,MN,HT,F(6,6,16),G(6,5),U(6),RI,RJ,INC(4),DELR
      COMMON /C2/ UE(6),YD,YN,TMN,HMIN,DINT,YCON,TA(4),IPG,XG,YG,IRD
      COMMON /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG
      COMMON /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),MQ,IVER,IWR
      COMMON /C5/ Q(100,4),GA(2),IAD(4,5),XGG,YGG,IAS,TDA,TDB,TDC,IPU
      COMMON /C6/ NROSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,
     X            IHD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA
      COMMON /QCOM/ N,DR,IX,IY,TT(16,21),KTC,IXX,IYY,RAD,Z(50,50,3),TD
C       CALCULATE SECTOR AREA SOURCE VECTOR Q(NQ,I)
C          N = INDEX OF RADIAL ARC
C          I = 1: P 1 EMISSION RATE
C          I = 2:  P 2 EMISSION RATE
C          I = 3: AREA STACK HEIGHT
      IF(NCULP.EQ.0) GO TO 16
      DO 10 I9=1,100
      DO 10 J9=1,21
      DO 10 K9=1,4
      IQ(I9,J9,K9)=0
   10 CONTINUE
      DO 15 I9=1,100
      DO 15 J9=1,21
      DO 15 K9=1,NPOL
      QZBAR(I9,J9,K9) = 0.0
   15 CONTINUE
   16 CONTINUE
      NQ=0
  700 NQ=NQ+1
      IF (NQ.LE.100) GO TO 702
      NQ = NQ - 1
      IF (ICHK(NREC).EQ.1) GO TO 110
      ICHK(NREC) = 1
      IF (NROSE.EQ.0.AND.NCULP.EQ.0) GO TO 110
C   PRINT WARNING MESSAGE FOR THIS RECEPTOR
      WRITE(IWR,111)
  111 FORMAT('0',9X,'WARNING:  MORE THAN 100 ARCS ARE REQUIRED FOR ',
     X 'CALCULATION OF AREA CONTRIBUTION.',/,20X,'AREA SOURCES BEYOND',
     X ' 100TH ARC ARE NOT INCLUDED IN CALCULATION.')
      IPG = IPG + 3
      GO TO 110
  702 DO701I=1,3
  701 Q(NQ,I)=0.
      Q(NQ,4)=(N-1)*DELR
      R=(N-1)*DR
C          R: RADIAL UPWIND DISTANCE
      KT=(N-1)*DELR/2500.+1.
C          KT: CONTROLS INCREMENT TO NEXT ARC
      IF(KT.GT.4) KT=4
C          KTC: CONTROLS NUMBER OF POINTS ALONG ARC (DINT+1)
      HN=0.
      DO90LL=1,KTC
C          DETERMINE WHICH AREA SOURCE THE POINT FALLS ON.  IF ON THE LINE
C             TWO ARE AVERAGED.  IF ON AN INTERSECTION, FOUR ARE AVERAGED
      T=TT(K,LL)
      TI=RI+R*COS(T)
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CALQ.

```
      TJ=RJ+R*SIN(T)                                                    CALQ0580
      IF(TI.LT.TDA.OR.TI.GT.TDB) GOTO90                                 CALQ0590
      IF(TJ.LT.TDA.OR.TJ.GT.TDC) GOTO90                                 CALQ0600
      I=TI                                                              CALQ0610
      J=TJ                                                              CALQ0620
      IF(I.LT.1) I=1                                                    CALQ0630
      IF(J.LT.1) J=1                                                    CALQ0640
      D=TI-I                                                            CALQ0650
      IF(ABS(D-0.5).LE.TD) GOTO78                                       CALQ0660
      IF(D-0.5) 82,78,86                                                CALQ0670
   78 D=TJ-J                                                            CALQ0680
      IF(ABS(D-0.5).LE.TD) GOTO79                                       CALQ0690
      IF(D-0.5) 80,79,81                                                CALQ0700
   79 IA=1                                                              CALQ0710
      JA=5                                                              CALQ0720
      GCTO101                                                           CALQ0730
   80 IA=2                                                              CALQ0740
      JA=3                                                              CALQ0750
      GOTO101                                                           CALQ0760
   81 IA=2                                                              CALQ0770
      JA=4                                                              CALQ0780
      GCTO101                                                           CALQ0790
   82 D=TJ-J                                                            CALQ0800
      IF(ABS(D-0.5).LE.TD) GOTO83                                       CALQ0810
      IF(D-0.5) 84,83,85                                                CALQ0820
   83 IA=3                                                              CALQ0830
      JA=2                                                              CALQ0840
      GOTO101                                                           CALQ0850
   84 IA=3                                                              CALQ0860
      JA=3                                                              CALQ0870
      GOTO101                                                           CALQ0880
   85 IA=3                                                              CALQ0890
      JA=4                                                              CALQ0900
      GOTO101                                                           CALQ0910
   86 D=TJ-J                                                            CALQ0920
      IF(ABS(D-C.5).LE.TD) GOTO87                                       CALQ0930
      IF(D-0.5) 88,87,89                                                CALQ0940
   87 IA=4                                                              CALQ0950
      JA=2                                                              CALQ0960
      GCTO101                                                           CALQ0970
   88 IA=4                                                              CALQ0980
      JA=3                                                              CALQ0990
      GCTO101                                                           CALQ1000
   89 IA=4                                                              CALQ1010
      JA=4                                                              CALQ1020
  101 CN=0.                                                             CALQ1030
      IF(I.EQ.IXX) IA=3                                                 CALQ1040
      IF(J.EQ.IYY) JA=3                                                 CALQ1050
      IC(NC,LL,1)=I                                                     CALQ1060
      IC(NC,LL,2)=J                                                     CALQ1070
      IC(NQ,LL,3)=IA                                                    CALQ1080
      IC(NC,LL,4)=JA                                                    CALQ1090
      DC808LD=1,3                                                       CALQ1100
  808 C(LD)=0.                                                          CALQ1110
      DC802IR=1,4                                                       CALQ1120
      IV=I+IAD(IR,IA)                                                   CALQ1130
      JV=J+IAD(IR,JA)                                                   CALQ1140
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CALQ, continued.

```
      DC801L=1,NPOL                                                     CALQ1150
  801 C(L)=C(L)+Z(IV,JV,L)                                              CALQ1160
      IF(Z(IV,JV,3).LE.0.1) GOTO802                                     CALQ1170
      CN=CN+1.                                                          CALQ1180
      C(3)=C(3)+Z(IV,JV,3)                                              CALQ1190
  802 CONTINUE                                                          CALQ1200
      C(1)=C(1)/4.                                                      CALQ1210
      C(2)=C(2)/4.                                                      CALQ1220
      IF(CN.GT.0.5) GOTO803                                             CALQ1230
      C(3)=1.                                                           CALQ1240
      GCTO804                                                           CALQ1250
  803 C(3)=C(3)/CN                                                      CALQ1260
  804 IF(R.GT.0.) GOTO103                                               CALQ1270
      DC201LA=1,3                                                       CALQ1280
  201 Q(NQ,LA)=C(LA)                                                    CALQ1290
      IF(NCULP.EQ.0) GO TO 100                                          CALQ1300
      DC98K9=1,NPOL                                                     CALQ1310
   98 QZBAR(NQ,LL,K9)=C(K9)                                             CALQ1320
  100 CONTINUE                                                          CALQ1330
      GCTC102                                                           CALQ1340
  103 IF(LL.NE.1.AND.LL.NE.KTC) GOTO104                                 CALQ1350
C          TPAPEZOIDAL INTEGPATION APPLIED                              CALQ1360
      DC203LB=1,NPOL                                                    CALQ1370
  203 C(LB)=C(LB)*0.5                                                   CALQ1380
  104 DC204LC=1,NPOL                                                    CALQ1390
      QZBAR(NQ,LL,LC)=C(LC)/DINT                                        CALQ1400
  204 Q(NQ,LC)=Q(NQ,LC)+C(LC)                                           CALQ1410
      IF(C(1)+C(2).LE.0.) GOTO90                                        CALQ1420
      Q(NQ,3)=Q(NQ,3)+C(3)                                              CALQ1430
   99 HN=HN+1.                                                          CALQ1440
   90 CCNTINUE                                                          CALQ1450
      DC202LD=1,NPOI                                                    CALQ1460
  202 Q(NQ,LD)=Q(NQ,LD)/DINT                                            CALQ1470
      IF(HN.GT.0.5) GOTO105                                             CALQ1480
      Q(NQ,3)=1.                                                        CALQ1490
      GCTC102                                                           CALQ1500
  1C5 Q(NQ,3)=Q(NQ,3)/HN                                                CALQ1510
  102 N=N+INC(KT)                                                       CALQ1520
      IF (N.LE.MX+1) GO TO 700                                          CALQ1530
C          IF NEXT ARC IS BEYOND AREA GRID, RETURN                      CALQ1540
  110 Q(NQ+1,4)=(N-1)*DELS                                              CALQ1550
      RETURN                                                            CALQ1560
      END                                                               CALQ1570
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine CALQ, continued.

```
      SUBRCUTINE AREA
      DIMENSION C(2)
      COMMON /DELCQ/ PARCAL(100,2)
      CCMMON /C1/ K,MX,MN,HT,F(6,6,16),G(6,5),U(6),RI,RJ,INC(4),DELR
      CCMMON /C2/ UE(6),YD,YN,TMN,HMIN,DINT,YCON,TA(4),IPG,XG,YG,IPD
      COMMON /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG
      COMMON /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVER,IWR
      COMMCN /C5/ Q(100,4),GA(2),IAD(4,5),XGG,YGG,IAS,TDA,TDB,TDC,IPU
      COMMON /C6/ NROSE,NCUIF,IPC(2),NPC,LPNAM(4),ITIT(20),IPNCH,
     X            IHD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA
      COMMCN /ACOM/ PI,SZA(6),ABAR(2),AROSE(16,2),XS(6)
      DO 500 IPP=1,NQ
      PARCAL(IPP,1)=0.0
      PARCAI(IPP,2)=0.0
  500 CCNTINUE
      Y=YD
C        CALCULATE SECTOR CONCENTPATION FROM AREA SOURCE VECTOR (O)
      DC338IS=1,6
C        IS: CCNTROLS STABILITY CLASS
      IF(IS.EQ.5) Y=YN
      IC=ICA(IS)
      DC338IU=1,6
C        IU: CONTOLS WIND SPEED CLASS
C        IF FREQUENCY IS ZERO, SKIP
      IF(F(IS,IU,K).LE.0.) GOTO338
      X=Y*YCON*F(IS,IU,K)
      C(1)=0.
      C(2)=0.
      IR=1
      DVLPI=Q(2,4)-Q(1,4)
  701 R=Q(IR,4)
      DVLR=DVLRI
      DVLFI=Q(IR+1,4)-R
      WZ=(Q(IR,3)*0.1)**UF(IS)
      WS=U(IU)*WZ
      DO801JA=1,NPOL
      DF=WS*GA(JA)
  801 DECAY(JA)=EXP(F/DF)
      RXS=R+XS(IS)
      IF(RXS-5000.)311,313,310
  310 IZ=1
      GCTO327
  311 IF(RXS.GE.500.) GOTO313
      IZ=3
      GCTO327
  313 IZ=2
  327 SZ=G(IZ,IC)*RXS**G(IZ+3,IC)
      IF(SZ.LE.0.) GOTO346
      IF(SZ.GE.HX(IS)) GOTO317
      STK2=Q(IR,3)*Q(IR,3)
      SB=-0.5*STK2/(SZ*SZ)
      S=PI*EXP(SB)/(SZ*WS)
      GCTC319
C        LID HAS BEEN REACHED
  317 IRI=IR
  702 R=Q(IRI,4)
      DVLR=DVLRI
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine AREA.

```
      DVLRI=Q(IRI+1,4)-R
      WZ=(Q(IRI,3)*0.1)**UF(IS)
      WS=U(IU)*WZ
      S=1.0/(WS*H(IS))
      DO802JB=1,NPOL
      DF=WS*GA(JB)
  802 DECAY(JB)=EXP(R/DF)
      IF(IRI.EQ.1.OR.IRI.EQ.NQ) GOTO320
      DO465JC=1,NPOL
      STEP=(Q(IRI,JC)*S*(DVLR+DVLRI))/DECAY(JC)*X
      PARCAL(IRI,JC)=PARCAL(IRI,JC)+STEP
  465 C(JC)=C(JC)+STEP
      GOTO366
C        TRAPEZOIDAL INTEGRATION APPLIED
  320 DO445JF=1,NPOL
      STEP=(Q(IRI,JF)*S*DVLR)/DECAY(JF)*X
      PARCAL(IRI,JF)=PARCAL(IRI,JF)+STEP
  445 C(JF)=C(JF)+STEP
  366 IRI=IRI+1
C        LOOPS TO RHO(MAX)
      IF(IRI.LE.NQ) GOTO702
      GOTO347
  319 IF(IR.EQ.1.OR.IR.EQ.NQ) GOTO323
C        LID HAS NOT BEEN REACHED
C        TRAPEZOIDAL INTEGRATION APPLIED
      DO462JI=1,NPOL
      STEP=(Q(IR,JI)*S*(DVLR+DVLRI))/DECAY(JI)*X
      PARCAL(IR,JI)=PARCAL(IR,JI)+STEP
  462 C(JI)=C(JI)+STEP
      GOTO346
C        TRAPEZOIDAL INTEGRATION APPLIED
  323 DO423JK=1,NPOL
      STEP=(Q(IR,JK)*S*DVLR)/DECAY(JK)*X
      PARCAL(IR,JK)=PARCAL(IR,JK)+STEP
  423 C(JK)=C(JK)+STEP
  346 IR=IR+1
C        LOOPS TO RHO(MAX)
      IF(IR.LE.NQ) GOTO701
  347 DO447JL=1,NPOL
      AROSE(K,JL)=AROSE(K,JL)+C(JL)
  447 ABAR(JL)=ABAR(JL)+C(JL)
  338 CONTINUE
      RETURN
      END
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine AREA, continued.

```
      SUBROUTINE ARCAL
      COMMON /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVER,IWP
      COMMON /C5/ Q(100,4),GA(2),IAD(4,5),XGG,YGG,IAS,TDA,TDB,TDC,IPU
      COMMON /C6/ NROSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,
     X            IND(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA
      COMMON /QCOM/ N,DR,IX,IY,TT(16,21),KTC,IXX,IYY,RAD,Z(50,50,3),TD
      COMMON /TABLE/ IIA(50,50)
      COMMON / TABUL/ IQ(100,21,4),QZBAR(100,21,2)
      COMMON /DELCQ/ PARCAL(100,2)
      COMMON /DISPLA/ ZSOURC(2500,2)
      DIMENSION QTOT(2),ICRD(4,2)
C   SUBROUTINE COMPUTES INDIVIDUAL SOURCE CONTRIBUTIONS FROM SECTOR
C     IQ(L9,LX,LJ)                 INDICATES COORDINATES OF AREA SOURCES
C                                  SAMPLED IN ARC L9, SAMP PT LX, POLL LJ
C     QZBAR(L9,LX,LJ)/Q(L9,LJ) =   FRACTION OF TOTAL CONTRIBUTION OF ARC
C                                  L9 DUE TO SAMP PT LX FOR POLLUTANT LJ
C     Z(IV,JV,LJ)/QTOT(LJ) =       FRACTION OF CONTRIBUTION OF SAMP POINT
C                                  LX, ARC L9, DUE TO AREA SOURCE (IV,JV)
C                                  FOR POLLUTANT LJ
C     PARCAL(L9,LJ) =              TOTAL CONTRIBUTION FROM ARC L9
C     ZSOURC(INDEX,LJ) =           CONTRIBUTION FROM AREA SOURCE INDEX
C                                  FOR POLLUTANT LJ
C
C   LOOP THROUGH NQ ARCS IN SECTOR
      DO 100 L9=1,NQ
      IF (PARCAL(L9,1).EQ.0.0.AND.PARCAL(L9,2).EQ.0.0) GO TO 100
C   LOOP THROUGH KTC SAMPLING POINTS IN ARC
      DO 50 LX=1,KTC
      IA=IQ(L9,LX,3)
      IF (IA.EQ.0) GO TO 50
      JA=IQ(L9,LX,4)
      DO 5 LJ=1,NPOL
    5 QTOT(LJ)=0.0
C   DETERMINE AND STORE COORDINATES OF AREA SOURCES AT THIS SAMP PT
      DO 10 IR=1,4
      IV=IQ(L9,LX,1)+IAD(IR,IA)
      JV=IQ(L9,LX,2)+IAD(IR,JA)
      ICRD(IR,1)=IV
      ICRD(IR,2)=JV
      DO 8 LJ=1,NPOL
    8 QTOT(LJ) = QTOT(LJ) + Z(IV,JV,LJ)
   10 CONTINUE
      DO 40 IR=1,4
      IV=ICRD(IR,1)
      JV=ICRD(IR,2)
      INDEX=IIA(IV,JV)
      IF (INDEX.EQ.0) GO TO 40
      DO 30 ICU=1,NPC
      LJ = IPC(ICU)
      IF (PARCAL(L9,LJ).EQ.0.0) GO TO 30
C   COMPUTE CONTRIBUTION FROM AREA SOURCE INDEX
      VALUE=PARCAL(L9,LJ)*QZBAR(L9,LX,LJ)/Q(L9,LJ)*Z(IV,JV,LJ)/QTOT(LJ)
      ZSOURC(INDEX,LJ)=ZSOURC(INDEX,LJ)+VALUE
   30 CONTINUE
   40 CONTINUE
   50 CONTINUE
  100 CONTINUE
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine ARCAL.

```
      RETURN                                                            ARCL0580
      END                                                               ARCL0590
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine ARCAL, continued.

```
      SUBROUTINE POINT
      DIMENSION S(2)
      COMMON /C1/ K,MX,MN,HT,F(6,6,16),G(6,5),U(6),RI,RJ,INC(4),DELR
      COMMON /C2/ UE(6),YD,YN,TMN,HMIN,DINT,YCON,TA(4),IPG,XG,YG,IRD
      COMMON /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG
      COMMON /C4/ DECAY(2),ICA(6),ICF(6),H(6),HX(6),GB(2),NQ,IVER,IVR
      COMMON /C5/ Q(100,4),GA(2),IAD(4,5),XGG,YGG,IAS,TDA,TDB,TDC,IPU
      COMMON /C6/ NROSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,
     X           IHD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA
      COMMON /PCOM/ PH(200),PR(200),PS(200,4),PX(200),PY(200),PE(200),
     *XX(200),DHF(200),WA(16),WB(16),PROSE(16,2),CV,IPS,RAT,TOA,PBAR(2),
     *PCINTS(200,2)
C        CALCULATE SECTOR CONCENTRATION FROM POINT SOURCES
C         IF LOOPS TO IPS (NUMBER OF POINT SOURCES)
      IP=1
C         FINDS UPWIND (XP) AND CROSSWIND (YP) DISTANCES FROM RECEPTOR
C            TO SOURCE
  667 VX=PX(IP)-RI
      VY=PY(IP)-RJ
      XP=(VY*WA(K)+VX*WB(K))*RAT*CV
      IF(XP.LE.0.) GOTO659
      YP=ABS((VY*WB(K)-VX*WA(K))*RAT*CV)
      TM=XP*0.19891
C         IF SOURCE MAKES NO CONTRIBUTION TO RECEPTOR, SKIP TO NEXT
      IF(YP.GT.TM) GOTO659
      IF(PH(IP).GE.50.) GOTO654
      SZI=50.-PH(IP)
      IF(SZI.GT.30.) SZI=30.
      GOTO635
  654 SZI=0.
  635 Y=YD
      DO777IS=1,6
C         IS: CONTROLS STABILITY CLASS
      IF(IS.EQ.5) Y=YN
      IC=ICF(IS)
      WZ=(PH(IP)*0.1)**UE(IS)
      IF(SZI.LE.0.) GOTO650
      XS=(SZI/G(1,IC))**(1./G(4,IC))
      IF(XS.GE.5000.) GOTO624
      XS=(SZI/G(2,IC))**(1./G(5,IC))
      IF(XS.GE.500.) GOTO624
      XS=(SZI/G(3,IC))**(1./G(6,IC))
      GOTO624
  650 XS=0.
  624 DIST=XP+XS
      IF(DIST-5000.)641,643,640
  640 IZ=1
      GOTO644
  641 IF(DIST.GE.500.) GOTO643
      IZ=3
      GOTO644
  643 IZ=2
  644 SZ=G(IZ,IC)*DIST**G(IZ+3,IC)
      IF(SZ.LE.0.) GOTO777
      DO658IU=1,6
C         IU: CONTOLS WIND SPEED CLASS
C         IF FREQUENCY IS ZERO, SKIP
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine POINT.

```
      IF(F(IS,IU,K).LE.0.) GOTO658                                      POI00580
      WS=U(IU)*WZ                                                       POI00590
      DO744JA=1,NPOL                                                    POI00600
      DF=WS*GA(JA)                                                      POI00610
  744 DECAY(JA)=EXP(XP/DF)                                              POI00620
      IF(FB(IP).LE.0.) GOTO637                                          POI00630
C             HOLLANDS EQN.                                             POI00640
      DH=FR(IP)/WS                                                      POI00650
      DH=DH*(1.4-0.1*IC)                                                POI00660
      GOTO638                                                           POI00670
C             BRIGGS PLUME RISE  (1970)                                 POI00680
  637 XSX=XP/XX(IP)                                                     POI00690
      IF(XSX.GT.3.5) GOTO608                                            POI00700
      DH=FB(IP)/WS*XP**0.6667                                           POI00710
      GOTO638                                                           POI00720
  608 DH=DHF(IP)/WS                                                     POI00730
  638 PHDH=PH(IP)+DH                                                    POI00740
      IF(PHDH.GT.H(IS)) GOTO658                                         POI00750
      PHDH=PHDH*PHDH                                                    POI00760
      IF(SZ.GE.HX(IS)) GOTO614                                          POI00770
      B=-0.5*(PHDH/(SZ*SZ))                                             POI00780
      IF(ABS(B).GT.60.) GOTO658                                         POI00790
      WW=WS*XP*SZ                                                       POI00800
      DO611JA=1,NPOL                                                    POI00810
  611 S(JA)=FS(IP,JA)/WW                                                POI00820
      WW=EXP(B)                                                         POI00830
      DO612JB=1,NPOL                                                    POI00840
  612 S(JB)=S(JB)*WW                                                    POI00850
      GOTO615                                                           POI00860
  614 WW=WS*XP*H(IS)                                                    POI00870
      DO613JC=1,NPOL                                                    POI00880
      JD=JC+2                                                           POI00890
  613 S(JC)=FS(IP,JD)/WW                                                POI00900
  615 B=Y*YCON*F(IS,IU,K)                                               POI00910
      DO715JB=1,NPOL                                                    POI00920
      X=S(JB)*B/DECAY(JB)                                               POI00930
      IF(NCULP.NE.0)  POINTS(IP,JB)=POINTS(IP,JB)+X                     POI00940
      PROSE(K,JB)=PROSE(K,JB)+X                                         POI00950
  715 PBAR(JB)=PBAR(JB)+X                                               POI00960
  658 CONTINUE                                                          POI00970
  777 CONTINUE                                                          POI00980
  659 IP=IP+1                                                           POI00990
      IF(IP.LE.IPS) GOTO667                                             POI01000
C          LOOPS UNTIL ALL POINT SOURCES EVALUATED                      POI01010
      RETURN                                                            POI01020
      END                                                               POI01030
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine POINT, continued.

```
      SUBROUTINE SWITCH
      COMMON /REG/ IFLG,NCALB,IOCAL,NCL,NCL1,NCL2,RXS(200),RYS(200),
     X             OBS(200,2),SGDS(200,2),IPNCHS(50),NROSES(50),
     X             NCULPS(50),NLARSS(200),NRAMS(200),CALC(200,2),
     X             KFLG,JFLG,COBS(2),NRAM,CORREL(100),BKGR(2),RX,RY,
     X             TOTC(200,2)
      COMMON/C6/NROSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,
     X             IHD(16),IWDP(16),NPOL,NREC,CTOF,ICHK(200),ICHA
      COMMON/LARS/SGD(2),PAV(3,2),CCON(2),NLARS
C   SUBROUTINE STORES (BEFORE REGRESSION ANALYSIS; KFLG=1) OR
C   SUBROUTINE RETRIEVES (AFTER REGRESSION ANALYSIS; KFLG=2)
C   CALIBRATION RECEPTOR DATA
C      NCL         INDEX DENOTING PARTICULAR RECEPTOR BEING PROCESSED
C      NCL1        INDEX TO COUNT NO. OF RECEPTORS FOR POLLUTANT 1
C      NCL2        INDEX TO COUNT NO. OF RECEPTORS FOR POLLUTANT 2
C      NCALB       TOTAL NUMBER OF CALIBRATION RECEPTORS TO BE INPUT
C   JFLG IS SET TO ZERO UPON RETRIEVAL OF DATA FOR LAST CALIB RECEPTOR
C
      NCL = NCL + 1
      GO TO (100,200),KFLG
C   STORE CALIBRATION RECEPTOR INPUT DATA
  100 RXS(NCL) = RX
      RYS(NCL) = RY
      IF (COBS(1).EQ.0.) GO TO 110
      NCL1 = NCL1 + 1
  110 IF (COBS(2).EQ.0.) GO TO 120
      NCL2 = NCL2 + 1
  120 OBS(NCL,1) = COBS(1)
      OBS(NCL,2) = COBS(2)
      SGDS(NCL,1) = SGD(1)
      SGDS(NCL,2) = SGD(2)
      IPNCHS(NCL) = IPNCH
      NROSES(NCL) = NROSE
      NCULPS(NCL) = NCULP
      NLARSS(NCL) = NLARS
      NRAMS(NCL) = NRAM
      NROSE = 0
      NCULP = 0
      RETURN
C
C   RETRIEVE CALIBRATION RECEPTOR INPUT DATA
  200 RX = RXS(NCL)
      RY = RYS(NCL)
      SGD(1) = SGDS(NCL,1)
      SGD(2) = SGDS(NCL,2)
      IPNCH = IPNCHS(NCL)
      NROSE = NROSES(NCL)
      NCULP = NCULPS(NCL)
      NLARS = NLARSS(NCL)
      NRAM = NRAMS(NCL)
      IF (NCL.EQ.NCALB) JFLG = 0
      RETURN
      END
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine SWITCH.

```
      SUBROUTINE REGR
      COMMON /REG/ IPLG,NCAIR,IOCAL,NCL,NCL1,NCL2,RXS(200),RYS(200),
     X             OBS(200,2),SGDS(200,2),IPNCHS(50),NROSES(50),
     X             NCULPS(50),NLARSS(200),NRAMS(200),CALC(200,2),
     X             KPLG,JPLG,COPS(2),NRAM,CORREL(100),BKGR(2),RX,RY,
     X             TOTC(200,2)
      COMMON /C2/ UE(6),YD,YN,THN,HMIN,DINT,YCON,TA(4),IPG,XG,YG,IRD
      COMMON/C3/RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG
      COMMON/C4/DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVER,IWR
      COMMON/C6/NROSE,NCULP,IPC(2),NFC,LPNAM(2),ITIT(20),IPNCH,
     X            IHD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA
      DIMENSION AAA(2),BBB(2)
      INTEGER NFLG(2)
      DATA NFLG/2*0/
C  SUBROUTINE CARRIES OUT REGRESSION ANALYSIS:
C  COMPUTES SLOPE AND INTERCEPT AND PRINTS RESULTS
C
      WRITE(IWR,5) IHD,ITIT,IRUN
    5 FORMAT('1',35X,16A4,//,26X,20A4,/,61X,'RUN ',I5)
C
      DO 500 IPOL=1,NPOL
C  NCLL = NUMBER OF CALIBRATION RECEPTORS FOR POLLUTANT IPOL
      IF (IPOL.EQ.1) NCLL = NCL1
      IF (IPOL.EQ.2) NCLL = NCL2
      SX = 0.
      SY = 0.
      SX2 = 0.
      SY2 = 0.
      SXY = 0.
C  NCL = TOTAL NUMBER OF CALIBRATION RECEPTORS
      DO 20 IREC=1,NCL
C  OBS(IREC,IPOL) = MEASURED (INPUT) VALUE FOR RECEP IREC, P IPOL
C  OP = OBSERVED VALUE FOR RECEP IREC, P IPOL
C  CP = CALCULATED VALUE FOR RECEPTOR IREC, P IPOL
      IF (OBS(IREC,IPOL).EQ.0.) GO TO 20
      OP = OBS(IREC,IPOL) - BKGR(IPOL)
      CP = CALC(IREC,IPOL)
      SX = SX + CP
      SY = SY + OP
      SX2 = SX2 + CP*CP
      SY2 = SY2 + OP*OP
      SXY = SXY + OP*CP
   20 CONTINUE
      AN = FLOAT(NCLL)
      XM = SX/AN
      YM = SY/AN
      TSX = SX2 - SX*XM
      TSY = SY2 - SY*YM
      TXY = SXY - SX*YM
      BBB(IPOL) = TXY/TSX
      AAA(IPOL) = YM-BBB(IPOL)*XM
      R = TXY/SQRT(TSX*TSY)
      R2 = R*R
      RSS = BBB(IPOL)*BBB(IPOL)*TSX
      RMS = RSS
      DSS = TSY - RSS
      TSS = TSY
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine REGR.

```
      NDF = NCLL - 2
      DMS = DSS/NDF
      VARB = DMS/TSX
      VARA = VARB*SX2/AN
      STDVB = SQRT(VARB)
      STDVA = SQRT(VARA)
C
C  PRINT RESULTS
C     BBB         SLOPE OF REGRESSION EQUATION
C     AAA         INTERCEPT OF REGRESSION EQUATION
C     STDVA       STANDARD DEVIATION OF INTERCEPT AAA
C     STDVB       STANDARD DEVIATION OF SLOPE BBB
C     BKGR        BACKGROUND CONCENTRATION
C     R           CALCULATED CORRELATION COEFFICIENT
C     R2          MULTIPLE CORRELATION
C     CORREL      5% CONFIDENCE LEVEL CORRELATION COEFFICIENT
C     RSS         REGRESSION SUM SQUARES
C     DSS         DEVIATION SUM SQUARES
C     TSS         TOTAL SUM SQUARES
C     RMS         REGRESSION MEAN SQUARES
C     DMS         DEVIATION MEAN SQUARES
C     NDF         REGRESSION NUMBER DEGREES OF FREEDOM
C     NDT         DEVIATION NUMBER DEGREES OF FREEDOM
C     XM          MEAN CALCULATED CONCENTRATION
C     YM          MEAN OBSERVED CONCENTRATION
      WRITE(IWR,200) LPNAM(IPOL)
  200 FORMAT('0',10X,9('*****'),'  CALIBRATION PROCEDURE RESULTS: ',A4,
     X  '  ',9('*****'),//,5X,
     X  'REGRESSION COEFFICIENTS:  OBSERVED (MEASURED MINUS BACKGROUND)'
     X  ,' VERSUS CALCULATED CONCENTRATIONS',//,10X,
     X  'PARAMETER',16X,'VALUE',28X,'STANDARD DEVIATION',/)
      WRITE(IWR,205) BBB(IPOL),STDVB,AAA(IPOL),STDVA,BKGR(IPOL)
  205 FORMAT(13X,'SLOPE',14X,F10.2,30X,F10.2,/,13X,
     X  'INTERCEPT',10X,F10.2,' MICROGRAMS/CU. METER',9X,F10.2,
     X  ' MICROGRAMS/CU. METER',/,13X,'BACKGROUND',9X,F10.2,
     X  ' MICROGRAMS/CU. METER')
      WRITE(IWR,225)
  225 FORMAT('0', 4X,'ANALYSIS OF VARIANCE AND 5% CONFIDENCE LEVEL ',
     X  'TEST FOR CORRELATION COEFFICIENT',//,33X,'DEGREES OF',9X,
     X  'SUM OF',11X,'MEAN',33X,'CORRELATION ',
     X  'COEFFICIENT',/,10X,
     X  'SOURCE',18X,'FREEDOM',11X,'SQUARES',9X,'SQUARES',9X,
     X  'R - SQUARED ',9X,'CALCULATED',4X,'5% CONF. LEVEL',/)
      NDT = NCLL - 1
      WRITE(IWR,230) RSS,RMS,R2,R,CORREL(NDF),NDF,DSS,DMS,NDT,TSS
  230 FORMAT(13X,'REGRESSION',15X,'1',11X,F10.2,6X,F10.2,8X,F10.2,10X,
     X  F10.2,6X,F10.2,//,13X,'DEVIATIONS',/,13X,'ABOUT REGRESSION',8X,
     X  I2,11X,F10.2,6X,F10.2,//,13X,'TOTAL',19X,I2,11X,F10.2,/)
      WRITE(IWR,235) YM,XM
  235 FORMAT(10X,'AVERAGED OBSERVED CONCENTRATION:  ',2X,F10.2,
     X  ' MICROGRAMS/CU. METER',/,10X,'AVERAGED CALCULATED ',
     X  'CONCENTRATION:  ',F10.2,' MICROGRAMS/CU. METER',/)
C  SET FLAG IF CORRELATION (R) IS LOWER THAN 5% CONF LEVEL
C  CORRELATION (CORREL) FOR NO. DEGREES OF FREEDOM (NDF)
      IF (R.LT.CORREL(NDF)) NFLG(IPOL) = 1
  500 CONTINUE
C
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine REGR, continued.

```
C
C  DETERMINE AND PRINT THE ACTION TO BE TAKEN BASED ON INPUT
C  PARAMETERS AND RESULTS OF REGRESSION ANALYSIS
      WRITE(IWR,5) IHD,ITIT,IRUN
      WRITE(IWR,818)
  818 FORMAT('0')
      WRITE(IWR,819)
  819 FORMAT(' ',24('*****'),'*')
      IF (NFLG(1).EQ.1.OR.NFLG(2).EQ.1) GO TO 800
      WRITE(IWR,820)
  820 FORMAT(1X,'CALCULATED CORRELATION COEFFICIENTS GREATER ',
     X  'THAN OR EQUAL TO THEORETICAL (5% CONF. LEVEL) VALUES;')
      IF (IOCAL.EQ.3) GO TO 700
      WRITE(IWR,821)
  821 FORMAT(1X,'COMPUTED REGRESSION CONSTANTS WILL BE USED TO ',
     X  'CALIBRATE CALCULATED CONCENTRATIONS.')
      DO 850 I=1,NPOL
      CA(I) = AAA(I)
  850 CB(I) = BBB(I)
      GO TO 920
  700 IFLG = 1
      WRITE(IWR,822)
  822 FORMAT(1X,'PROCESSING STOPS.')
      GO TO 920
  800 CONTINUE
      WRITE(IWR,823)
  823 FORMAT(1X,'CALCULATED CORRELATION COEFFICIENT LESS THAN ',
     X  'THEORETICAL (5% CONF. LEVEL) VALUE FOR',10X,';')
      IF (NFLG(1).EQ.1) WRITE(IWR,824) LPNAM(1)
  824 FORMAT('+',84X,A4)
      IF (NFLG(2).EQ.1) WRITE(IWR,825) LPNAM(2)
  825 FORMAT('+',89X,A4)
      IF (IOCAL.NE.2) GO TO 900
      WRITE(IWR,826)
  826 FORMAT(1X,'DEFAULT VALUES (INTERCEPT=0,SLOPE=1) WILL BE USED ',
     X  'TO CALIBRATE CALCULATED CONCENTRATIONS.')
      DO 830 I=1,NPOL
      CA(I) = 0.0
  830 CB(I) = 1.0
      GO TO 920
  900 IFLG = 1
      WRITE(IWR,827)
  827 FORMAT(1X,'PROCESSING STOPS.')
  920 WRITE(IWR,819)
      IPG = 11
C
C  PRINT CALIBRATION RECEPTOR DATA
      DO 980 IPOL=1,NPOL
      IF (IPOL.NE.2.OR.IPG.LE.32) GO TO 101
      WRITE(IWR,5) IHD,ITIT,IRUN
      IPG = 4
  101 WRITE(IWR,105) LPNAM(IPOL)
  105 FORMAT('0',/,37X,'RECEPTOR DATA ASSOCIATED WITH REGRESSION ',
     X  'PARAMETERS: ',A4,//,62X,
     X  'CONCENTRATION (MICROGRAMS/CU. METER)',/,26X,
     X  'LOCATION',/,57X,'CALCULATED **',24X,
     X  'CALCULATED **',/,1X,
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine REGR, continued.

```
     X  'RECEPTOR ID',8X,'X COORD',7X,'Y COORD',15X,'UNCALIBRATED',
     X  9X,'OBSERVED *',7X,'CALIBRATED',/)
      IPG = IPG + 9
      DO 970 IREC=1,NCL
      IF (OBS(IREC,IPOL).EQ.0.) GO TO 970
      CALB = AAA(IPOL) + BBB(IPOL)*CALC(IREC,IPOL)
      SOBS = OBS(IREC,IPOL) - BKGR(IPOL)
      IF (IPG.LE.46) GO TO 108
      WRITE(IWR,5) IHD,ITIT,IRUN
      WRITE(IWR,105) LPNAM(IPOL)
      IPG = 13
  108 IPG = IPG + 1
      WRITE(IWR,110) NRAMS(IREC),RXS(IREC),RYS(IREC),CALC(IREC,IPOL),
     X  SOBS,CALB
  110 FORMAT(5X,A4,9X,F10.2,4X,F10.2,14X,F10.2,9X,F10.2,8X,F10.2)
  970 CONTINUE
  980 CONTINUE
      WRITE(IWR,985)
  985 FORMAT('0',//,1X,'*   OBSERVED = INPUT MEASURED VALUE - ',
     X  'INPUT BACKGROUND VALUE',/,1X,'**  BACKGROUND CONCENTRATION ',
     X  'IS NOT INCLUDED')
      IPG = 70
      RETURN
      END
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine REGR, continued.

```
      SUBROUTINE RECPR
      COMMON /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG
      CCMMON /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVER,IWR
      CCMMON /C6/ NROSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,
     X            IND(16),IWDR(16),NPOL,NREC,CTOP,ICHK(200),ICHA
      COMMON /REG/ IPLG,NCAIR,IOCAL,NCL,NCL1,NCL2,RXS(200),RYS(200),
     X            OBS(200,2),SGDS(200,2),IPNCHS(50),NROSES(50),
     X            NCULPS(50),NLARSS(200),NRAMS(200),CALC(200,2),
     X            KPLG,JPLG,COBS(2),NRAM,CORREL(100),BKGR(2),RX,RY,
     X            TOTC(200,2)
      DIMENSION IAST(2)
      DATA IAST/'*','*'/
C  INITIALIZE FLAG FOR PRINTING OF WARNING FOOTNOTE
      DATA IWRN/0/
C  SUBROUTINE PRINTS TABLE OF CALIBRATED AREA, POINT AND TOTAL
C  CONCENTRATIONS FOR ALL RECEPTORS
C
C  INITIALIZE COUNTERS FOR NUMBER OF LARSEN RECEPTORS
      DO 5 I=1,NPOL
    5 IPC(I) = 0
C  PRINT HEADING
      WRITE(IWR,2) IND,ITIT,IRUN,LPNAM
    2 FORMAT('1',35X,16A4,//,26X,20A4,/,61X,'RUN ',I5,////,44X,
     X  'CALIBRATED CONCENTRATION (MICROGRAMS/CU. METER)',//,50X,
     X  'POLLUTANT: ',A4,37X,'POLLUTANT: ',A4,//,1X,
     X  'RECEPTOR',   6X,'X',10X,'Y',11X,'POINT',8X,'AREA',35X,
     X  'POINT',8X,'AREA',/,1X,'NO.  ID',5X,'COORD',6X,'COORD',8X,
     X  'SOURCES',6X,'SOURCES',3X,'BACKGROUND',5X,'TOTAL',9X,
     X  'SOURCES',6X,'SOURCES',3X,'BACKGROUND',5X,'TOTAL',/)
      IPG = 14
C
C  PRINT RESULTS FOR EACH OF NREC RECEPTORS:
C     OBS - AREA SOURCE CONTRIBUTION
C     CALC - POINT SOURCE CONTRIBUTION
C     BKGR - INPUT BACKGROUND
C     TOTC - TOTAL CONCENTRATION
      DC 500 I=1,NREC
      IF (IPG.LE.50) GO TO 50
      IF (IWRN.EQ.1) WRITE(IWR,40)
   40 FORMAT('0','*  WARNING:  MORE THAN 100 ARCS ARE REQUIRED FOR ',
     X  'CALCULATION OF AREA CONTRIBUTION.',/,14X,
     X  'AREA SOURCES BEYOND 100TH ARC ARE NOT INCLUDED IN ',
     X  'CALCULATION.')
      IWRN = 0
      WRITE(IWR,2) IND,ITIT,IRUN,LPNAM
      IPG = 14
   50 IPG = IPG + 1
      WRITE(IWR,60) I,NRAMS(I),RXS(I),RYS(I),
     X  (CALC(I,J),OBS(I,J),BKGR(J),TOTC(I,J),J=1,NPOL)
   60 FORMAT(1X,I3,1X,A4,2(1X,F10.2),2X,F10.1,2X,F10.1,3X,F10.1,
     X  2X,F10.1,5X,F10.1,2X,F10.1,3X,F10.1,2X,F10.1)
C  IF ICHK = 1 FOR RECEPTOR I, NOT ALL AREA SOURCES WERE INCLUDED
      IF (ICHK(I).NE.1) GO TO 490
      WRITE(IWR,70) (IAST(J),J=1,NPOL)
   70 FCRMAT('+',55X,A1,52X,A1)
      IWRN = 1
  490 IF (NLARSS(I).EQ.0) GO TO 500
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine RECPR.

```
      IF (NLARSS(I).EQ.2) GO TO 495                                    RCPR0580
      IPC(1) = IPC(1) + 1                                              RCPR0590
      IF (NLARSS(I).EQ.1) GO TO 500                                    RCPR0600
  495 IPC(2) = IPC(2) + 1                                              RCPR0610
  500 CONTINUE                                                         RCPR0620
      IF (IWRN.EQ.1) WRITE(IWR,40)                                     RCPR0630
      RETURN                                                           RCPR0640
      END                                                              RCPR0650
```

Figure E.1   CDMQC FORTRAN Listing. Subroutine RECPR, continued.

```
      SUBROUTINE ZVALU2(P,Z)
C
C   SUBROUTINE TO COMPUTE REDUCED NORMAL VARIATE (Z) FROM
C   PERCENT VALUE (P) EXPRESSED IN DECIMAL
C
      A0 = 2.515517
      A1 = 0.802853
      A2 = 0.010328
      B1 = 1.432788
      B2 = 0.189269
      B3 = 0.001308
      U = SQRT(ALOG(1./(P*P)))
      Z = U-(A0+A1*U+A2*U*U)/(1.+B1*U+B2*U*U+B3*U*U*U)
      RETURN
      END
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine ZVALU2 (P,Z)

```
      SUBRCUTINE STAV                                                   STAV0010
      COMMON/LARS/SGD(2),PAV(3,2),CCON(2),NLARS                         STAV0020
      COMMON /C2/ UE(6),YD,YN,TMN,HMIN,DINT,YCON,TA(4),IPG,XG,YG,IRD    STAV0030
      COMMCN /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG     STAV0040
      COMMON /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVPR,IWR   STAV0050
      COMMON/C6/NROSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,         STAV0060
     X           IPD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA         STAV0070
      COMMON /REG/ IFLG,NCAIR,IOCAL,NCL,NCL1,NCL2,RXS(200),RYS(200),    STAV0080
     X             OBS(200,2),SGDS(200,2),IPNCHS(50),NROSES(50),        STAV0090
     X             NCULPS(50),NLARSS(200),NRAMS(200),CALC(200,2),       STAV0100
     X             KFLG,JFLG,COBS(2),NRAM,CORREL(100),BKGR(2),RX,RY,    STAV0110
     X             TOTC(200,2)                                          STAV0120
C  SUPRCUTINE CARRIES OUT LARSEN STATISTICAL ANALYSIS                   STAV0130
C                                                                       STAV0140
      TTIME = 8760.                                                     STAV0150
      DO 500 I=1,NPOL                                                   STAV0160
      IF (PAV(1,I).EQ.0.0.OR.IPC(I).EQ.0) GO TO 500                     STAV0170
C  TEST FOR NUMBER OF AVERAGING TIMES (NAVE) FOR POLLUTANT I            STAV0180
      DO 10 K=1,3                                                       STAV0190
      IF (PAV(K,I).LE.0.) GO TO 30                                      STAV0200
      NAVE = K                                                          STAV0210
   10 CONTINUE                                                          STAV0220
   30 DC 200 K=1,NAVE                                                   STAV0230
C  PRINT HEADING FOR POLLUTANT I AND AVERAGING TIME K                   STAV0240
      WRITE(IWR,2) IHD,ITIT,IRUN,PAV(K,I),LPNAM(I)                      STAV0250
    2 FORMAT('1',35X,16A4,//,26X,20A4,/,61X,'RUN ',I5,///,36X,          STAV0260
     X  'STATISTICAL DATA AT SELECTED RECEPTORS (MICROGRAMS/CU. ',      STAV0270
     X  'METER)',//,1X,                                                 STAV0280
     X  'AVERAGING TIME = ',F4.1,' HOURS',/,59X,                        STAV0290
     X  'POLLUTANT: ',A4,/,119X,'EXPECTED',/,55X,'EXPECTED',13X,        STAV0300
     X  'EXPECTED',13X,'STANDARD',15X,'ANNUAL',/,1X,'RECEPTOR',4X,      STAV0310
     X  'RECEPTOR',                                                     STAV0320
     X  34X,'GEOMETRIC',13X,'MAXIMUM',13X,'GEOMETRIC',12X,              STAV0330
     X  'ARITHMETIC',/,2X,'NUMBER',8X,'ID',7X,'X COORD',5X,             STAV0340
     X  'Y COORD',13X,'MEAN',13X,                                       STAV0350
     X  'CONCENTRATION',10X,'DEVIATION',15X,'MEAN',/)                   STAV0360
      IPG = 15                                                          STAV0370
      FREQ = 0.6/(TTIME/PAV(K,I))                                       STAV0380
      CALL ZVALU2(FREQ,ZFREQ)                                           STAV0390
      DO 400 J=1,NREC                                                   STAV0400
      IF (NLARSS(J).NE.I.AND.NLARSS(J).NE.3) GO TO 400                  STAV0410
      SGD(I) = SGDS(J,I)                                                STAV0420
      CCON(I) = TOTC(J,I)                                               STAV0430
C  COMPUTE STANDARD GEOMETRIC DEVIATION FOR AVERAGING TIME K            STAV0440
      SIGK = SGD(I)**(SQRT(ALOG(TTIME/PAV(K,I))/                        STAV0450
     X  ALCG(TTIME/24.)))                                               STAV0460
C  COMPUTE EXPONENT FOR CCNVERTING GEOMETRIC MEAN TO AVERAGING TIME K   STAV0470
      EXP = (ALOG(PAV(K,I)/24.)*(5.*ALOG(SGD(I))))/                     STAV0480
     X  ALCG(TTIME/24.)                                                 STAV0490
C  COMPUTE GEOMETRIC MEAN USING ARITHMETIC MEAN (CCON)                  STAV0500
      GEOM = CCON(I)/SGD(I)**(.5*ALOG(SGD(I)))                          STAV0510
C  COMPUTE GEOMETRIC MEAN AT AVERAGING TIME K                           STAV0520
      GEOM = GEOM*SGD(I)**EXP                                           STAV0530
C  COMPUTE MAXIMUM CONCENTRATION FOR AVERAGING TIME K                   STAV0540
      CMAX = GEOM*SIGK**ZFREQ                                           STAV0550
C  PRINT RESULTS FOR POLLUTANT I, AVERAGING TIME K, RECEPTOR J          STAV0560
      IF (IPG.LE.54) GO TO 145                                          STAV0570
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine STAV.

```
      WRITE(IWR,2) IND,ITIT,IRUN,PAV(K,I),LPNAM(I)
      IFG = 15
  145 WRITE(IWR,150) J,WRAMS(J),RXS(J),RYS(J),GEOM,CMAX,SIGK,CCON(I)
  150 FORMAT(2X,I4, 9X,A4,4X,F10.2,2X,F10.2, 8X,F10.2,12X,F10.2,10X,
     X  F10.2,12X,F10.2)
      IFG = IPG + 1
  400 CONTINUE
  200 CONTINUE
  500 CCNTINUE
      RETURN
      END
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine STAV, continued.

```
      BLOCK DATA                                                        BLKL0010
      COMMON /C1/ K,MX,MN,HT,F(6,6,16),G(6,5),U(6),RI,RJ,INC(4),DELR    BLKL0020
      CCMMON /C2/ UE(6),YD,YN,TMN,MMIN,DINT,YCON,TA(4),IPG,XG,YG,IRD    BLKL0030
      COMMON /C3/ RATG,IRUN,CA(2),CB(2),TK(16),AROS(2),PROS(2),TANG     BLKL0040
      CCMMON /C4/ DECAY(2),ICA(6),ICP(6),H(6),HX(6),GB(2),NQ,IVEP,IWR   BLKL0050
      COMMON /C5/ Q(100,4),GA(2),IAD(4,5),XGG,YGG,IAS,TDA,TDB,TDC,IPU   BLKL0060
      COMMON /C6/ NFOSE,NCULP,IPC(2),NPC,LPNAM(2),ITIT(20),IPNCH,       BLKL0070
     X            IHD(16),IWDR(16),NPOL,NREC,CTOF,ICHK(200),ICHA        BLKL0080
      COMMON /QCOM/ N,DR,IX,IY,TT(16,21),KTC,IXX,IYY,RAD,Z(50,50,3),TD  BLKL0090
      CCMMCN /ACOM/ PI,SZA(6),ABAR(2),AROSE(16,2),XS(6)                 BLKL0100
      CCMMCN /PCOM/ PH(200),PR(200),PS(200,4),PX(200),PY(200),PB(200),  BLKL0110
     *XX(200),DHP(200),WA(16),WB(16),PROSE(16,2),CV,IPS,RAT,TOA,PBAR(2),BLKL0120
     *POINTS(200,2)                                                     BLKL0130
      COMMCN /REG/ IFLG,NCAIR,ICCAL,NCL,NCL1,NCL2,RXS(200),RYS(200),    BLKL0140
     X             OBS(200,2),SGDS(200,2),IPNCHS(50),NROSES(50),        BLKL0150
     X             NCULPS(50),NLARSS(200),NRAMS(200),CALC(200,2),       BLKL0160
     X             KFLG,JFLG,COBS(2),NRAM,CORREL(100),BKGR(2),RX,RY,    BLKL0170
     X             TOTC(200,2)                                          BLKL0180
      COMMON/LARS/SGD(2),PAV(3,2),CCON(2),NLARS                         BLKL0190
      DATA G/2*2.539E-4,.0383,2*2.0886,1.2812,2*.04936,.1393,2*1.1137,  BLKL0200
     *.9467,.1154,.1014,.112,.9109,.926,.91,.7368,.2591,.0856,.5642,    BLKL0210
     *.6869,.865,1.2969,.2527,.0818,.4421,.6341,.8155/                  BLKL0220
      DATA TANG,U/78.75,1.5,2.45872,4.4704,6.92912,9.61136,12.51712/    BLKL0230
      DATA YCON,UE/0.1E7,0.1,0.15,0.2,0.25,0.25,0.3/                    BLKL0240
      DATA INC,IPG,IPS,IX,IY/1,2,4,4,70,0,1,1/                          BLKL0250
      DATA IXX,IYY,IAS/1,1,0/, TD/0.1E-3/                               BLKL0260
      DATA RAD,PI/57.2958,0.797885/                                     BLKL0270
      DATA IAD/0,0,1,1,0,1,0,1,4*0,4*1,0,1,1,0/                         BLKL0280
      DATA ICA,ICP/1,1,2,3,4,4,1,2,3,3*4/                               BLKL0290
      DATA IVER/76053/                                                  BLKL0300
      DATA JFLG,NCL,NCL1,NCL2,IFLG,KFLG/5*0,1/                          BLKL0310
      DATA NPOL,NREC/2,0/                                               BLKL0320
      DATA ABAR,PBAR,CCON/6*0/                                          BLKL0330
      DATA ICHK/200*0/                                                  BLKL0340
C                                                                       BLKL0350
C   CORREL: ARRAY PROVIDING LOOK-UP TABLE FOR 5% CONFIDENCE             BLKL0360
C   LEVEL FOR CALIBRATION CORRELATION COEFFICIENTS;  ALTHOUGH MAX OF    BLKL0370
C   50 X-Y PAIRS ALLOWED, CORREL IS MAGNITUDE OF 100 TO ALLOW FOR       BLKL0380
C   ANY FUTURE CHANGE IN MAX OF X-Y PAIRS                               BLKL0390
      DATA CORREL /         .997,     .950,     .878,     .811,     .754,BLKL0400
     1                      .707,     .666,     .632,     .602,     .576,BLKL0410
     2                      .553,     .532,     .514,     .497,     .482,BLKL0420
     3                      .468,     .456,     .444,     .433,     .423,BLKL0430
     4                      .413,     .404,     .396,     .388,     .381,BLKL0440
     5                      .374,     .367,     .361,     .355,     .349,BLKL0450
     6                      .344,     .339,     .335,     .330,     .325,BLKL0460
     7                      .321,     .319,     .312,     .308,     .304,BLKL0470
     8                      .301,     .298,     .294,     .291,     .288,BLKL0480
     9                      .285,     .282,     .279,     .276,     .273,BLKL0490
     .                      .271,     .268,     .266,     .264,     .262,BLKL0500
     .                      .259,     .257,     .255,     .252,     .250,BLKL0510
     .                      .248,     .246,     .245,     .243,     .241,BLKL0520
     .                      .239,     .237,     .236,     .234,     .232,BLKL0530
     .                      .231,     .229,     .228,     .226,     .225,BLKL0540
     .                      .223,     .222,     .220,     .219,     .217,BLKL0550
     .                      .216,     .215,     .213,     .212,     .211,BLKL0560
     .                      .210,     .209,     .207,     .206,     .205,BLKL0570
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine BLOCK DATA, continued.

```
     .              .204,     .203,     .202,     .201,      .200,
     .              .199,     .198,     .197,     .196,      .195/
C
      DATA IND/'C L ','I M ','A T ','O L ','O G ','I C ',
     X         'A L ','  D ','I S ','P E ','R S ','I O ',
     X         'N   ','M O ','D E ','L   '/
      DATA IWDR/'N   ','NNE ','NE  ','ENE ','E   ','ESE ',
     X         'SE  ','SSE ','S   ','SSW ','SW  ','WSW ',
     X         'W   ','WNW ','NW  ','NNW '/
      END
```

Figure E.1. CDMQC FORTRAN Listing. Subroutine BLOCK DATA, continued.